AIRCRAFT & MISSILES

A Chilton Publication APPLIED ENGINEERING FOR THE AEROSPACE INDUSTRIES December 1960

Special Report—Military Tells Industry

WHAT WE HAVE AND WHAT WE NEED . . . P 17

Gen. Lyman L. Lemnitzer
Chairman, Joint Chiefs of Staff

Gen. Thomas D. White
Chief of Staff, U. S. Air Force

Gen. George H. Decker
Chief of Staff, U. S. Army

Adm. Arleigh A. Burke
Chief of Naval Operations

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8 of hard-to-contain helium under a temperature span of 550°F.
9 Demonstrated control capability in cryogenic and other con-
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11 testing and continual applied research—means that Hadley is uniquely able to
12 assist in developing pressure system specifications for new liquid hydrogen systems.
13 If your concern is fluid control at low temperature with high reliability, check Hadley first.
14 Write for Information File AM-1095-2.
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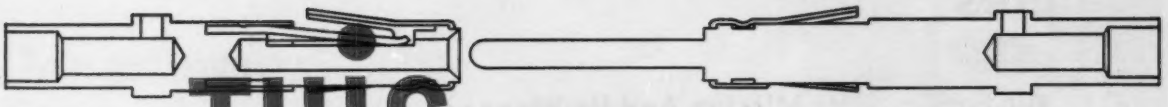
IN RACK AND PANEL CONNECTORS



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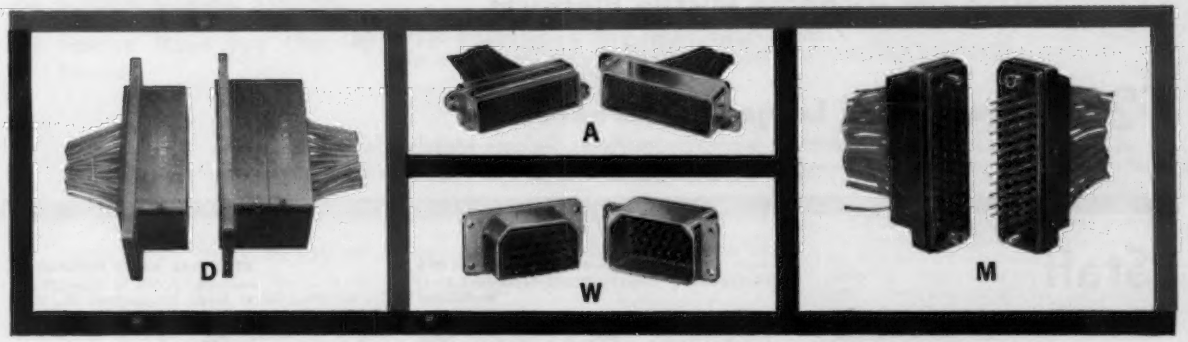

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December, 1960 *Volume 3, Number 12*

AIRCRAFT & MISSILES

APPLIED ENGINEERING FOR THE AEROSPACE INDUSTRIES

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THE COVER STORY—Portrayed on this month's cover are the men who bear the top-level burden of guarding our land, sea, and air frontiers. The proven resourcefulness of these men can find fulfillment only when backed to the fullest extent by the industrial and scientific resources of the Nation. The vital role of the aerospace industry complex has been covered in the special report starting on page 17.

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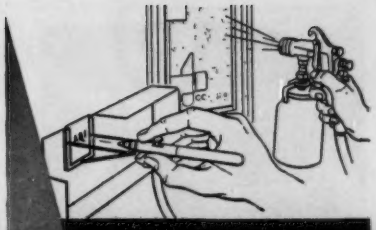

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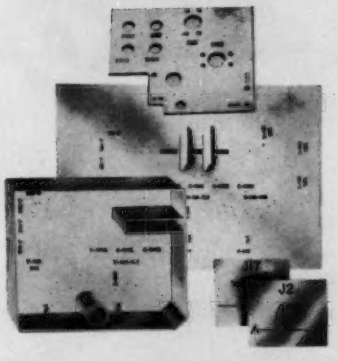

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3

Your Datebook

November 27-December 2
Annual Winter Meeting
American Society of Mechanical Engineers
Statler Hilton, N. Y., N. Y.

December 1-2
Meeting, Professional Group on Vehicular Communications
Institute of Radio Engineers
Sheraton Hotel, Philadelphia, Pa.

December 5-8
15th Annual Meeting and Astronautical Exposition
American Rocket Society
Shoreham Hotel, Washington, D. C.

December 6-8
Annual Meeting
National Aviation Trades Assn.
Oklahoma-Biltmore, Oklahoma City, Okla.

December 13-15
Eastern Joint Computer Conference
Hotel New Yorker, and Manhattan Center, N. Y., N. Y.

December 17
24th Wright Brothers Lecture
Natural History Bldg.
Smithsonian Institution, Washington, D. C.

December 26-31
127th Meeting
American Assn. for the Advancement of Science
New York, N. Y.

January 9-11
Seventh National Symposium on Reliability and Quality Control
Bellevue-Stratford Hotel
Philadelphia, Pa.

January 9-13
International Congress and Exposition
Society of Automotive Engineers
Cobo Hall, Detroit, Mich.

January 16-18
National Meeting
American Astronautical Society
Dallas, Texas

January 23-25
Annual Meeting
Institute of the Aeronautical Sciences
Hotel Astor, N. Y., N. Y.

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The compact, fully automatic unit shown at left, for example, measures 5x5x2 ft, weighs only 550 lb and provides 7½ to 10 tons of cooling on a 125°F day. It also provides 90,000 Btu per hour heating.

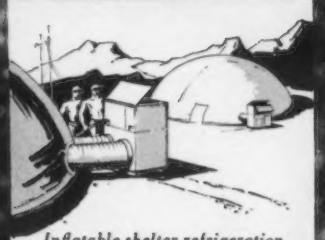
The heart of the system is a simple centrifugal Freon compressor which has only *one* moving part.

A hermetically sealed unit, it operates virtually without vibration and is unaffected by either attitude or oil level.

Essentially the same AiResearch air conditioning system used in today's jet airliners, these lightweight units have more than 500,000 hours of proven dependability.

Built to withstand rough handling in the field and operate dependably under the most severe weather conditions, rugged air conditioners of this same basic design are available, or can be built to provide from fractional tonnage up to any capacity of ground cooling desired.

• A brochure describing AiResearch ground air conditioning systems may be obtained by writing to Environmental Controls Project, Los Angeles Division.



Inflatable shelter refrigeration unit, 7½ tons capacity (unit shown above)

Helicopter transportable hut refrigeration unit, 1½ tons capacity

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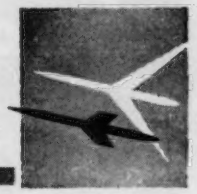

EDITORIAL

New Frontier . . .

The Journey Begins

OK, Mr. Kennedy, what are you going to do for us? That question, without doubt, is on the lips of all industry throughout the nation.

President-elect Kennedy has made several campaign statements about his space and defense program. Will he fulfill all the promises? He'll no doubt try.

If we have guessed right about Secretary of Defense, the man will be Senator Stuart Symington (D. Mo.), who goes along with Mr. Kennedy on most all points. (Others in the running for Secretary of Defense are Thomas Finletter, Frank Pace, and Dan Kimball).

A short time ago, we quizzed Senator Symington on his defense and space thinking. The senator wants to make more money available in the aerospace budget. In particular, Mr. Symington would like to speed up Midas, Samos, Discoverer, Saturn, and the B-70.

Reorganization of DOD and unification of space efforts are also in Mr. Symington's plans. The senator is already heading up a special Kennedy committee probing DOD organization. For a long time Senator Symington has been in favor of a constant air alert. So is Mr. Kennedy.

"All space vehicles, rockets, and other developments should be available for those uses most essential to this country's best interests, regardless of what agency has primary responsibility for them," states Mr. Symington. There's every indication to believe that Mr. Kennedy buys this too. Both the president-elect and the senator believe that manned aircraft will continue to have an important role in our defense make-up. No doubt, Mr. Symington will go along with the Air Force's proposed Spaceplane and Orbiting Command Post (See page 33). We are not convinced, however, that the senator takes the same views as Navy in regards to Polaris and anti-submarine warfare. If Mr. Symington goes to DOD as its chief, it appears that Air Force might be able to slack off on the sell while Army and Navy will have the real tough-sell campaign in regards to their proposed space missions.

Senator Symington made many of his proposals early in the presidential campaign. We wonder, who followed who? Perhaps, he and Mr. Kennedy just think alike in regard to our space and defense policy. If so, Mr. Symington may be a valuable man for the new administration to have on the DOD team.

Tom MacNew

Editor

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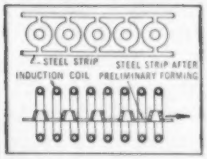
TYPICAL INDUCTION HEATING APPLICATIONS

PLASTIC COATING OF TOOL HANDLES

A production line operation for coating handles of tools at Whitney Metal Tool Co., Rockford, Ill. uses induction heating with excellent results. The handles only are heated by induction to the desired temperature then dipped into a vinyl chloride base coating material for a short period depending upon the thickness of coating desired. The plastic coating formed on the handles is then cured by immersion in a carbo-wax bath.

FORMING OF METAL STRIP FACILITATED BY PROGRESSIVE ANNEALING



Metal forming operations which require intermediate anneals to restore ductility can be facilitated by induction annealing the strip progressively. Diagram illustrates this procedure for partially formed thin austenitic stainless steel strip. The induction annealing operation is scheduled in the production line between two press operations. Metal strip and wire of other materials are also induction annealed in this manner.

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Reader's Orbit

Ask The Man Who . . .

. . . An article in your June 1960 issue has caught our attention. The article describes the "Swing to Tilt Table Devices for Gyro Testing" . . . using a glass etched resolver. We are interested in the resolver and would appreciate information as to availability and accuracy of such a device. . . . Please forward addresses and/or phone numbers of authors so that we can make direct contact.

R. C. Reenstra
Project Engineer
Eclipse-Pioneer Div.
The Bendix Corp.

Authors Perample and Sonntag are both Test Equipment Engineers, Dept. 42-01, AC Spark Plug Div., Delta Plant, P.O. Box 622, Milwaukee, Wis.

Patent Problems

. . . Enjoyed the editorial "Legalized Counterfeiting?" very much . . . would like to have permission to reprint it as a guest-editorial in the next issue of Strategic Industries Bulletin. . . . The Airborne Research & Development Corp. case (State Your Case, A&M November) . . . has an interesting recent development . . . the U. S. has issued a patent on this item, which at the time of testimony was only proprietary. Dick Hahn . . . is still having trouble with Air Force who insists on ignoring the legends on his drawings.

Jeff Funk,
Executive Secretary
Strategic Industries Assoc.

Not . . . Now

. . . There is an error in your November issue. The caption under the picture on page 18 should read that Bondcheck can "now" detect stress cracks . . . it reads Bondcheck can "not" . . .

I understand that such accidents do happen. I believe that there is a special breed of gremlin that lives in typewriters whose pleasure it is to create the particular error of changing the word "now" to "not." We had it happen in the important conclusions of a final complex report being sent to a customer a couple of years ago . . .

Incidentally, since reliability is the tag word these days, I wonder if you ever thought about large booklets or magazines in such terms? There are one hundred thousand or one million individual items, any one of which can be an error. Even if there are four or five "typos," the reliability index is not bad at all. Naturally . . . when you make errors in the future, we request that you make them in reference to other products.

Frank S. Catlin,
Marketing Development
Magnaflux Corp.
Subsidiary of General Mills

Well Dones

. . . We appreciate . . . the time and effort you took to do a good job with the LR-115 rocket engine story (October, 60).

L. C. Mallet,
General Manager
Pratt & Whitney Aircraft

. . . very pleased with the way the article "How To Test Miniature Gyros" was set up . . . think your people did a fine job . . .

Joseph Davidson,
President
Rototest Laboratories, Inc.

The Strength To Move Mountains

. . . saw your October 1960 picture of the observatory which houses the "200-in. telescope on Mount Wilson." (Space Navigation, The Challenge and The Progress.) It looks very much like Mount Palomar. Either Mount Wilson's reflector has grown along with other inflated items, or the dome has floated to another mountain top. Will this slight shift in reference point affect the future of star-guided flight?

Roy J. Cibulk

We can explain circles around the Wilson-Palomar mix-up but it won't change the fact that we made a large faux pas.
The truth: Mount Wilson is the 100-in. scope. It is just outside Pasadena (with a beautiful view of the city). It is operated by the Carnegie Institution of Washington, D. C.
The truth: Mount Palomar is the 200-in. scope. It is 130 mi from Pasadena (the view is hazy). It is operated by the Carnegie Institution and Cal Tech.
Miscellany: Both use the same address and letterhead (813 Santa Barbara Street, Pasadena, California); they use the same staff and the same lab building.

New Books

THE MANNED MISSILE. By Ed Rees. Duell, Sloan and Pearce, 1960. 182 pp., $3.50. This is the story of the B-70. It is a convincing argument against the notion that manned aircraft has reached the point of diminishing returns in global strategy. It describes the design philosophy behind this new breed of aircraft, the technological advances it has already motivated, and the tragic setbacks its development has suffered through anemic funding.

THEORY OF MECHANICAL VIBRATION. By K. N. Tong. Wiley, 1960. 348 pp., $9.75. A study of the physical laws which govern vibratory motion. The material presented here has been drawn from a theory-centered course given to beginning graduate students and qualified seniors. Prior knowledge, assumed by the author, includes: differential equations, undergraduate mechanics and mathematics. The book is divided into four chapters as follows: (1) Systems with a Single Degree of Freedom; (2) Systems with Two Degrees of Freedom; (3) Systems with Several Degrees of Freedom; (4) Vibration of Elastic Bodies. An appendix is also included which covers the basic ideas of matrix algebra.

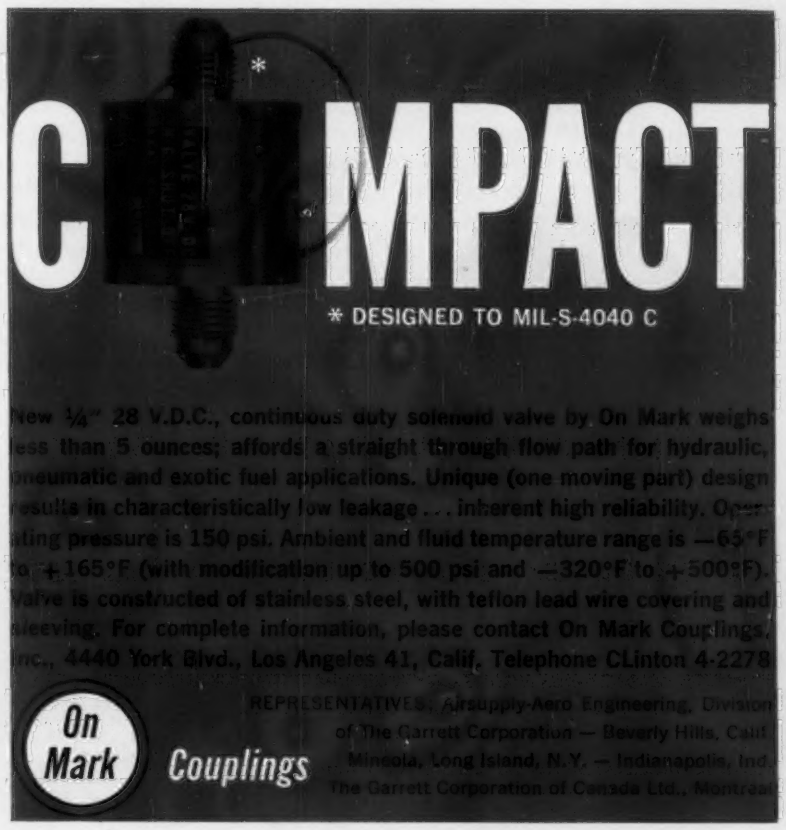
ENGINEER'S VEST POCKET BOOK. By W. A. Thomas, H. A. Spalding, Z. Pavlovich. Ottenheimer, 1960. 192 pp., $.90. A wealth of engineering data is packed in this handy booklet (2⅝ x 5½ in.) for students, draftsmen, designers and engineers. A marginal index is used to categorize the contained data under 12 headings as follows: Mathematics, Building, Mechanics, Heat, Hydraulics, Pipes, Electricity, Surveying, Costing, Mining, Chemistry, and Miscellaneous Data. The information is presented in a direct and concise manner; brief examples are provided to illustrate basic math principles.

AIRCRAFT AND MISSILE DESIGN AND MAINTENANCE HANDBOOK. By C. A. Overbey. Macmillan, 1960. 369 pp., $9.75. This is a practical handbook for mechanics, inspectors, draftsmen and designers. It contains a wide selection of most-commonly used data on A and MS standards, materials and processes related to the aircraft and missile technology. Some 160 tables are provided as related to mathematics, conversion, color coding, standard hardware sizes, symbols, time factors, strength ratings, tolerances, acceptable edge distance requirements, and hole sizes for standard bolts and rivets.

MECHANICS OF MATERIALS. By A. Higdon, E. H. Ohlsen, and W. B. Stiles. Wiley, 1960. 502 pp., $7.75. This extensively illustrated book is designed for a first course in mechanics of materials, with major emphasis on the elastic range of stress. The authors presume a basic grounding in statics and calculus. Illustrative examples and problems have been provided throughout. Major topics are grouped under the following chapter headings: Centric Loading, Torsional Loading, Flexural Loading-Stresses, Flexural-Loading-Deflections, Statically Indeterminate Beams, Combined Loading, Columns, Repeated Loading, Dynamic Loading, and Connections.

SYMPOSIUM ON NEWER METALS—Special Technical Publication No. 272. 218 pp., $7.25; to ASTM members $5.80. This book contains the studies presented at the Third Pacific Area National Meeting of the American Society For Testing Materials, San Francisco, October 15 and 16, 1959. Metallurgists, engineers, and designers should find this volume highly useful. Subject matter is treated under the following headings: Properties of Refractory Metals, Nuclear and Light Metals, Processing of New Metals. Illustrations and references are provided throughout.

. . . *continued on page* 46


C MPACT
* DESIGNED TO MIL-S-4040 C
New ¼" 28 V.D.C., continuous duty solenoid valve by On Mark weighs less than 5 ounces; affords a straight through flow path for hydraulic, pneumatic and exotic fuel applications. Unique (one moving part) design results in characteristically low leakage . . . inherent high reliability. Operating pressure is 150 psi. Ambient and fluid temperature range is —65°F to +165°F (with modification up to 500 psi and —320°F to +500°F). Valve is constructed of stainless steel, with teflon lead wire covering and sleeving. For complete information, please contact On Mark Couplings, Inc., 4440 York Blvd., Los Angeles 41, Calif. Telephone CLinton 4-2278
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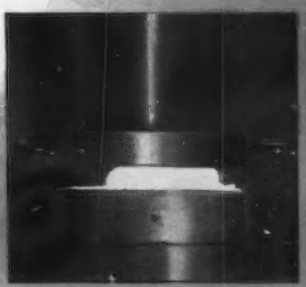
BENDIX CHROME CERAMETALIX®

New Bendix high-temperature material resists oxidation, acids, caustics...retains strength at 3000°F.

Chrome Cerametalix is the latest product of the Bendix Cerametalix laboratories. A unique chromium based cermet (ceramic-metallic material), it is ideally suited for applications in corrosive or oxidizing atmospheres in the 2000° to 3000°F. range. It combines resistance to heat, oxidation, and erosion with strength and hardness. Chrome Cerametalix offers great promise in aircraft, missile, and gas turbine engine components, and in a wide range of industrial processes including the steel and petroleum processing industries. In addition, the ability to machine and work Chrome Cerametalix with conventional methods and equipment makes it especially attractive to designers.

For complete information on this remarkable new material, write Cerametalix Sales Department.

Bendix PRODUCTS DIVISION South Bend, IND.

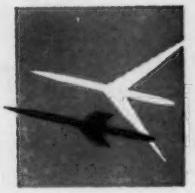


FORGEABLE, WORKABLE—Chrome Cerametalix can be forged and hot worked.

MACHINEABLE—This material can be precisely machined using conventional methods and equipment.

MICRO-SURFACE FINISH—Chrome Cerametalix can be polished to a micro-surface finish with standard machines.

Data Capsule



SUMMARY OF MANAGEMENT TRENDS AND TECHNICAL DEVELOPMENTS IN THE AEROSPACE INDUSTRIES

MISSILES AND SPACE VEHICLES

Design

LUNAR-LANDING CAPSULE being developed by Aeronutronic will "absorb" impact loads by crushable structure. Capsule, which is part of the NASA-JPL Ranger program, has been dropped by helicopters in tests.

MERCURY CAPSULE INTERIORS reportedly cover about 12 different basic configurations. Interior design changes with the mission. Later capsules may be designed for re-entry at 15 G's.

ALTITUDE CONTROL will not be a critical problem in first manned Redstone-boosted suborbital flight this February. In first re-entry from orbit, however, it will be vital. So will correct firing of retros in a vacuum. First orbiting Astronaut will have 122 controls at his glove-tips for various functions: 57 electrical switches, 31 fuses, 34 mechanical levers.

SPHERICAL MOTOR, a solid propellant, has been developed by Thiokol to propel Nike-Zeus last stage.

LARGE SOLID-FUEL BOOSTERS for vehicles weighing up to seven million lbs are in the design study phase under NASA contract. Grand Central Rocket Co. is designing a first stage for vehicles in one million lb class. Thiokol Chemical is designing first stage for seven-million lb class. Aerojet-General is studying stages for vehicles in both weight ranges.

EXPLORER VIII (orbited Nov. 3) is designed to give most detailed data to date on micrometeorites. Payload is 90-lb top-like structure constructed around a cylindrical instrument column. Roughly similar structure will be employed in the S-45 Ionosphere Beacon satellite, though S-45 will also have a large loop antenna at the equator.

APOLLO may be designed as three-man saucer-shaped glide vehicle. One concept calls for a command center in launch and re-entry to house crew, propulsion section for emergency return to earth, and mission section with living quarters for extended flights. Apollo is NASA's next step in manned spacecraft beyond Mercury.

POLARIS GUIDANCE SYSTEM will be lightened by over 100 per cent in advanced versions of the missile. This is accomplished by use of beryllium and miniaturization of electronic components.

Development

J-2 ROCKET ENGINES, being developed by Rocketdyne for Saturn upper stages, are slated to complete a development and qualification program within five years. They will be liquid hydrogen fueled, with 200,000 lb thrust.

1500-MILE POLARIS A-2 will have fiberglass-wound section stage motors produced by Hercules Powder Co. Less advanced models, dubbed Polaris A-1, are used on first five missile subs. These have second stage motor cases of 4335 steel. A-2 flight tests are under way.

SATURN TOWER is now a 310 ft steel skeleton at Cape Canaveral. Frame of the 2800-ton tower is finished. Complete structure is to be ready by Spring.

PROTECTIVE SUIT for satellite repairmen is being developed by General Electric. Suit would have built-in protection against "extreme conditions of outer space."

ASTRONAUTIC SHIP able to launch, track and recover space vehicles is planned by the Navy. Under present policy, Air Force has sole responsibility for launching military space vehicles.

SPACE TRANQUILIZERS? Experimental program now beginning at Navy's centrifuge, Johnsville, Penna., is studying effects of various compounds on spacemen during launch and re-entry.

LUNAR AND PLANETARY PROJECTS at NASA's JPL for this fiscal year will cost $50 million, 65% of this sum going to industry.

RANGER PROJECT will include five flights of JPL-designed spacecraft. First flights will be orbiting tryout of Ranger systems launched by Atlas Agena B boosters. First Ranger flight in 1961 will follow highly elliptical orbit. Moon impact shot not seen before 1962.

FIRST MISSION of JPL's Mariner will be fly-by of Venus in 1962. Second Mariner will be deep space probe. Mariner mission in 1963 will further the state of the art for a 1964 Mars effort. Mariner uses Centaur. Saturn-boosted version, called Voyager, is slated to reach Venus in 1965.

NUCLEAR ROCKET CONTRACTOR will be chosen without the usual six-month preliminary design studies. NASA and AEC is inviting proposals from several manufacturers for an immediate R & D program.

SKYBOLT "PEP" PROGRAM is speeding up development of the missile at Douglas Aircraft. Program grew out of the Program Evaluation Review Technique (PERT) developed for Polaris. PEP (Program Evaluation Procedure) is computerized system covering all factors in the development. Computer shows where bottlenecks may develop. Douglas is reportedly considering a smaller 500-mile version of Skybolt.

Production

BOMARC B is moving into quantity production at Boeing-Seattle.

DYNAMIC LOADING INSTRUMENT developed by Convair is a new method of testing rocket motor mounts under simulated blast-off. Units with a single actuator can produce 1½ million lb. of force.

Procurement

MISSILE PROCUREMENT OUTLAYS will top aircraft expenditures by 1963, according to some current predictions. Military spending for missiles and astronautics would reportedly climb from present $4-billion to $8-billion in 1970.

NASA has announced that it will provide the launch vehicles for commercial communication satellites.

AIRCRAFT

Design

DYNA-SOAR DESIGN must provide enough maneuverability for pilot to land on any air-base of his choice in the U. S. This hypersonic orbital vehicle, operating on the boost-glide principle, calls for an advanced communication data link and inertial guidance system. Dyna-Soar WSPO (Weapon System Project Office) will award contracts for these two systems early in 1961.

JFTD-12 new gas turbine engine being developed by Pratt & Whitney, features a free turbine drive which extracts energy from the exhaust gases of the jet to provide shaft horsepower.

Development

OFF-AGAIN, ON-AGAIN B-70 is now to be developed with its electronic equipment. Motorola has been reinstated manager of B-70's Mission and Traffic Control System.

NATIONWIDE MODERNIZATION of Air Traffic Control is to be completed by 1965, according to present FAA plans. Librascope recently received contract for computers used in the semi-automatic system.

VTOL PROTOTYPES will be developed under a joint Army, Navy, and Air Force program managed by the Navy. Services will set type specs which will form basis for a design competition. Resulting prototypes will be evaluated by agencies to be set up by the Military, which will provide equal tri-service funding over a four year period.

SUPERSONIC "STOL" CONTRACT will reportedly be awarded in January. Tactical Air Command closes bidding this month on this program.

Production

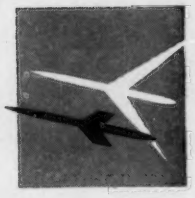
MAGNESIUM-TOOLING PROGRAM at Grumman Aircraft is based on calculations that maximum potential savings could exceed $400,000 per year. Firm reports that segregation of magnesium machining operations has "resolved" the safety problem.

Procurement

DEFENSE DEPARTMENT is slated to air procurement cost control problems before the Congress next month.

The Aerospace MAP

This capsule of business developments and trends is part of Aircraft & Missiles' Marketing Assistance Program, a research service to aid companies in the aerospace market.



Export Market Peaks But Competition Stiffens

The aeronautical export market will peak this year at about $1.4 billion, an all time high. How to keep it this high or even make it grow is a problem which industry has taken to the government.

A cross section of aircraft, engines, and parts producers has told the Department of Commerce it is concerned about the growing threat of a reverse flow, i. e., the import threat.

The U. S. airframe industry is 100 per cent privately owned and must compete in the world market with aircraft produced by government owned factories or government subsidized factories. Russia is becoming a competitor of serious concern in the world market.

Industry gave the Department of Commerce a report which listed tariff difficulties as a big bugaboo. Rates on aircraft run as high as 50 per cent.

Several common Market and Latin American countries are listed in a high tariff bracket in the report. Quotas, licensing and other devices also hold down sales of U. S. aircraft abroad. But, the greatest need cited in the report is for more liberal Government credit guarantees than are presently available from the U. S. Export-Import Bank to finance sales abroad.

Double and Redouble In General Aviation

Cessna Aircraft Co. has been analyzing its sales from general aviation and sees a market solidifying and growing. The company has doubled its sales in the last five years, and forecasts a redouble in the next five years. If these market forecasts are reliable, general aviation will ship over 11,000 units in 1965.

Others in general aviation are predicting the same optimistic market growth. There is a concerted effort to put planes in the hands of customers at a price that will make private air travel more competitive with all other types.

DOD Releases Funds For B-70 Development

The $155-million in new funds recently added to Air Force's B-70 program will allow work on a flying weapon system prototype. B-70 was dubbed the "hollow bomber" (A&M, Jan. '60) when program was limited to two stripped down versions without combat equipment. New flying vehicle will include defensive radar and rockets (Westinghouse Air Arm Div.) and traffic control equipment (Motorola).

Program now calls for one prototype for ground structural tests, one airframe test vehicle to be flight-tested in December, 1962, and two "fully operational" prototype bombers, to fly in 1963.

The additional funds in the current FY brings total now available to B-70 to $265-million. Congress limited its original request to $75-million as requested by the administration. Later, Congress gave the program an additional $184.3-million.

Machine Tool Upswing

The Armed Services may spend as much as $70-million in the current fiscal year for machine tool modernization. One reason for the rise in new orders: Introduction of numerical control into aerospace production. These machines are well suited for fast-changing designs. The Air Force is reportedly spending about $30-million on modernization, with the Army and Navy spending about $20-million each.

The Price of Everything

Those who have been strong in their criticism of DOD for cancelling some $2.1 billions in incomplete research and development projects are drawing return fire as knowing "the price of everything and the value of nothing." There are hundreds of sub-projects, tasks, and sub-tasks in overall projects like Navaho, Rascal, and Regulus; each sub area yields valuable R&D data even when a project is cancelled. All the money is not down the drain. Meanwhile R&D activity continues to grow into "big business" in the aerospace industries. DOD expenditures for Research, Development, Test, and Evaluation will be over $4.0 billion this year. Over half the money spent for R&D in this country has been spent in the last ten years.

THE CIVIL AIRCRAFT MARKET

AIRCRAFT SHIPMENTS

	Units		Value (000,000)	
Month	1960	1959	1960	1959
January	747	665	$96	$50
February	855	619	113	50
March	867	736	90	34
April	768	745	127	68
May	802	759	131	81
June	694	779	110	65
July	539	630	120	88
August	420	647	98	95
September	427	432	108	76
October	....	739	....	104
November	....	705	....	77
December	....	786	....	112
Year	....	8,242	....	$900
9 Mos.	6,119	6,012	$989	$608

PISTON ENGINE SHIPMENTS

	Units		Value (000,000)	
Month	1960	1959	1960	1959
January	1,025	873	$2	$3
February	1,039	954	3	3
March	1,141	921	3	3
April	1,064	947	2	3
May	894	921	2	2
June	772	979	2	3
July	579	844	2	2
August	873	747	2	2
September	864	804	2	2
October	....	1,051	....	4
November	....	1,060	....	4
December	....	1,051	....	4
Year	....	11,152	....	$35
9 Mos.	8,251	7,990	$21	$22

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ALTITUDE:

2,500 MILES

or 25,000 Feet

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The Aerospace MAP

Business Moves

Clauser Technology Corp. was recently formed to develop and produce missile electronic equipment.

Douglas Aircraft Co. is organizing Astropower Inc. as a subsidiary for research in exotic propulsion.

Ryan Aeronautical has formed two subsidiaries, Ryan Transdata Inc. (for data handling) and Ryan Communications (for communications problems). Ryan-San Diego is now a separate division of the firm.

Boeing Airplane Co. has established Boeing Associated Products to capitalize on commercial applications of its research. Boeing's Aero-Space Div. recently established a new department to study, design, and build antennas.

General Electric Co. now has a Space Power Operation in Cincinnati for designing and building systems which would power equipment in outer space vehicles.

Aerojet-General Corp. recently established a Spacecraft Div. in Azusa with complete responsibility for design, development, production and flight-testing of all Aerojet vehicles used in space operations.

Vanguard Air and Marine Corp. and **Briggs Associates Inc.** plan to merge.

Chance Vought Aircraft plans to change its name to Chance Vought Corp. to reflect expanded product lines.

Facilities

Lockheed Aircraft plans to install the following space chambers at its high altitude research complex, near Saugus, Calif.: The Guardite "C-5" eventually simulating up to 2,500,000 ft. and —320°F; the "C-1," accommodating mock-ups as large as an airliner fuselage; the "C-2" and "C-3" for testing humans up to 200,000 ft.; and the "C-4," checking small components up to 500°F and 200,000 ft.

Republic Aviation Corp. reports that its space simulation chamber can now reach altitudes of 300 miles.

Contracts

McDonnell Aircraft — $108,956,520 to produce additional F4H Phantom II jet fighters for the Navy.

General Electric Co.—$58,335,000 from Air Material Command for J79-8 turbojet production at the Large Jet Engine Department.

Lockheed Aircraft — $53,300,000 to produce additional P3V-1 aircraft for the Navy.

Convair—$41,303,720 to produce Tartar missiles for the Navy; $32.5-million from the Navy to produce Terrier and Tartar missile guidance and control groups and other components.

Convair—$32.5-million to produce missile guidance and control groups for Navy's Terrier and Tartar.

The Sperry Gyroscope Co.—$30-million award from Convair for additional production of navigation-bombing systems for B-58 Hustlers.

Applied Physics Lab — $26.8-million for continued R&D of guided missiles.

Sikorsky Aircraft—$23-million to produce additional HUS-1 cargo helicopters for the Navy.

Kaman Aircraft Corp. — $21-million Navy contract for production of HU2K Seasprite helicopters.

Northern Ordnance Inc.—$20.4-million Navy contract for additional production of MK 10 Terrier launching systems.

Pratt & Whitney—$14.8-million from the Navy to produce J57-P-43WB aircraft engines.

Chance Vought—$6-million for its prime contractor activities including final assembly and launch on NASA's Scout.

Sperry-Utah Engineering Lab—$3,130,009 for additional research and development on the Sergeant system.

TECHNICAL WRITERS

If word-smithing is your business, and space is your interest, Convair-Astronautics has an immediate position for you. Assignments involve the creation of maintenance, operation and inspection manuals for the top priority ATLAS ICBM weapon system.

Requirements: two years of college engineering, technical writing experience, plus an eye for the incisive word.

Write now to Mr. R. B. Merwin, Industrial Relations Administrator-Engineering, Department 130-90, 5583 Kearny Villa Road, San Diego, California.

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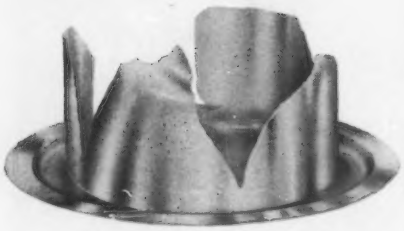
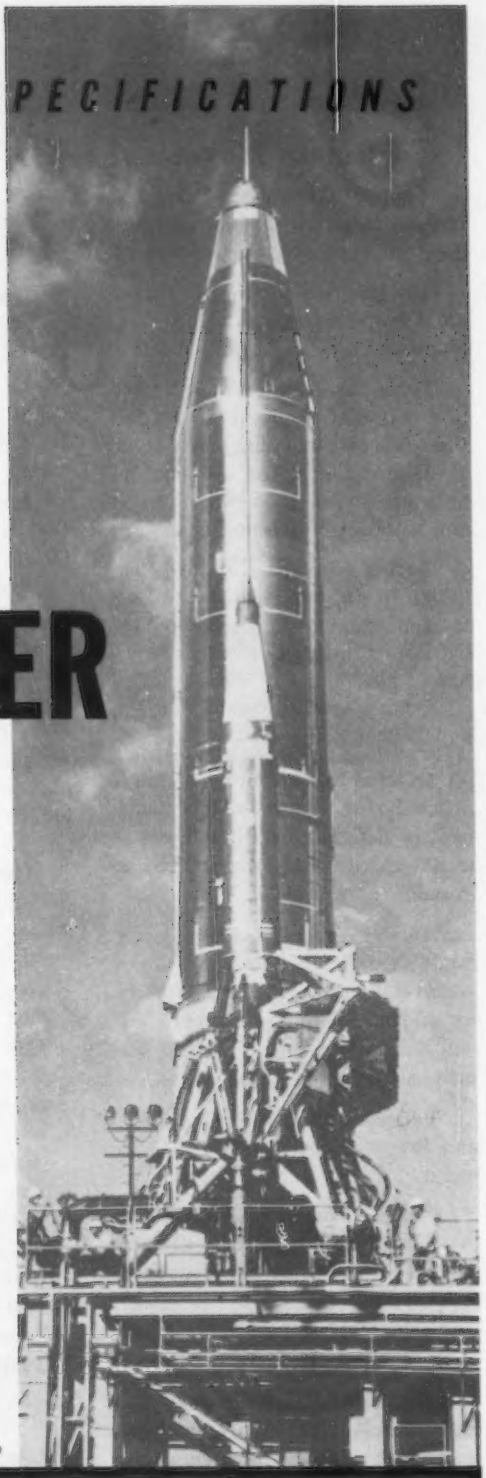
Circle 12 on Inquiry Card

FABRICATED TO YOUR SPECIFICATIONS

FROM JATO TO JUPITER



BS&B RUPTURE DISC



Adaptations of this metal rupture disc have found many uses in the Missile and Aircraft Industries. Here's why. A rupture disc can be built into a *lightweight* unit to relieve pressure; it will rip open instantly at a rated pressure and temperature without fragmentation; or it can be ruptured mechanically. There is a wide choice of materials and sizes—with pressure ratings from 3 to 100,000 psi.

Here are some current rupture disc applications: Jato bottles, pilot ejection systems, fuel oxidization systems, missile hydraulic systems, and over-pressure protection for test stands.

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U. S. AIR FORCE PHOTO

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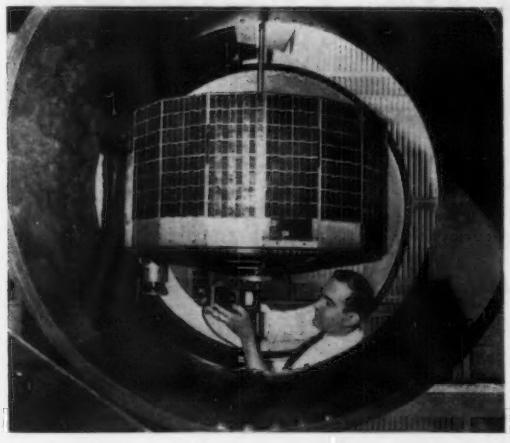
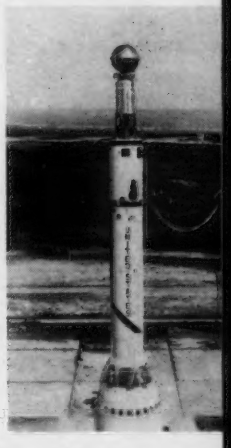
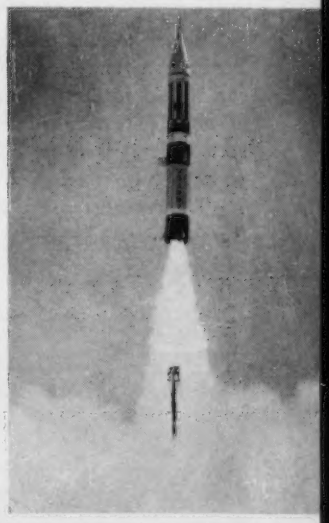
An Aircraft & Missiles / **SPECIAL REPORT**

What We Have And What We Need





The Aerospace Industries' biggest customers, the Armed Forces, tell about their missions and their weapons—The Challenge And The Progress. This report was compiled by months of research and personal interviews with top military men. Project editors follow: Philip Geddes, Air Force; S. Peter Kaprielyan, Army; John P. Kushnerick, Navy.



MILITARY TELLS INDUSTRY

Air Force . . . Its Missions And Its Weapons

Manned bombers are still the AF's biggest operational punch; Missile detection and an Aerospace Force are immediate goals; Twenty-seven Secret documents list problem areas for industry

Primary mission of the Air Force is to maintain a force which can strike instantly and decisively at any aggressor. Such a force is seen as the strongest deterrent to war.

The deterrence concept is stronger than any other in Air Force thinking. It is primarily a strategic concept. But, Air Force also has tactical and defense missions.

What They Have — Air Force hardware is, therefore, categorized into these specific mission-tasks (strategic, tactical, and defense). The arsenal of equipment is essentially aircraft and missiles. Vehicles now in an operational status are:

MOST POTENT, manned weapon system Air Force has in operation is the B-52 Stratofortress teamed with the KC-135 Stratotanker team. B-52 inventory was about 500 aircraft at the end of 1960 (fiscal). SAC has started to receive the "G" Model and the first "H" model is scheduled for completion early in 1961. B-52 carries 2 Hound Dogs and 1 nuclear bomb.

STRATEGIC

Aircraft		*Missiles*
B-47 E	B-58	SM-65
B-52 G, H	KC-97	
RB-47 H	KC-135 A	

TACTICAL

Aircraft		*Missiles*
F-100 D, F	B-57 B, C	TM-61 C
F-101 A, C	B-66 B	TM-76 A, B
F-104 C, D	RF-101	GAR-8
F-105 B, D	RB-66	GAM-83 A, B

DEFENSE

Aircraft	*Missiles*
F-101 B	GAR 1, 2, 3, 4
F-102 A	MB-1
F-106 A, B	IM-99 A

Defense Warning/Control	*Defense Support*
RC-121 D	C-124
Dew Line	C-130 A
SAGE	C-133 A, B
	H-43 B

The Aerospace Force — Air Force is now exploring, through its Air Research and Development Command (ARDC), many vehicles which will operate where there is no air, only space. The SM-65 Atlas ICBM operates in this space environment for part of its flight. The coming generation of manned space vehicles, X-15, and Dynasoar, are exploring the space environment for Air Force. The unmanned SAMOS, DISCOVERER, and MIDAS satellites will perform their missions almost entirely in space. Air Force obviously has a strong interest here, even though stated national policy is to use space for "peaceful purposes", with NASA doing most of the space exploration. There is a strong desire to have the combination of aircraft, missiles, satellites, and space vehicles called an Aerospace Force.

There is already in the works a Spaceplane which could "fly" into orbit, and an Orbiting Command Post from which SAC can control offensive and defensive operations. If authorization is given to proceed with these projects, the Air Force would truly be the Aerospace Force.

What They Need—With regard to manned aircraft, a general statement may be made that Air Force needs improvements in range, speed, payload, take-off and landing characteristics. These are needed always. Improvements in armament for such aircraft are also needed—increased rates of fire, accuracy and destructiveness.

Beyond these classical requirements, as the complexity and cost of weapons increase the requirement for new orders of precision and quality control in manufacture, and reliability in operation must be attained. In unmanned systems, ballistic missiles for example, even higher orders of reliability are required. This trend is expected to continue as space systems enter AF inventory. Systems currently under development and demanding such improvements are these:

Aircraft	*Warning*
B-70	Dew Line

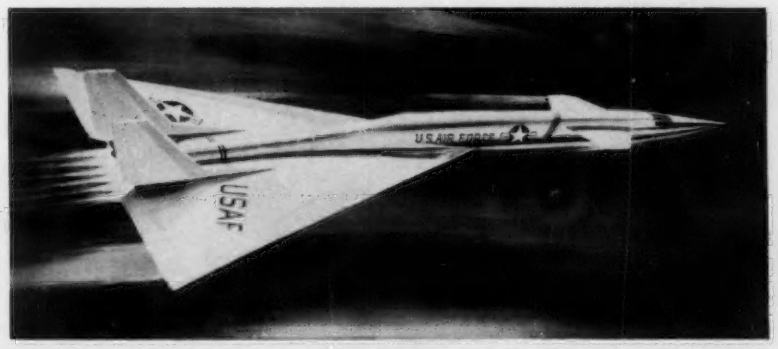
Missiles	*Space Systems*
SM-68	Midas
SM-80	Samos
GAM-87	
GAR-11	

The areas Air Force feels must be researched in the next ten years to meet its mission requirements are virtually unlimited. As a problems guide for industry, Air Force publishes the ARDC Technical Objectives Documents. They are 27 in number, one for each of the technical areas of interest. The purpose is to inform the industry of specific needs and to show industry its relation to systems under development. These documents are classified Secret. They are released through the Technical Release Division of Headquarters ARDC.

Two Way Street — Air Force believes, however, that industry can often contribute to identification of areas which may improve military capability beyond recognized and published goals. Contributions of this sort can be made from long range research and planning groups maintained within corporations and generally supported by company funds. Recognition of this two-way street is essential to maintaining military superiority.

"Like all commodities the price of national security is going up continually as weapon systems become more sophisticated. If the move into space is to be made with resolution and timeliness, new costs will be heaped on those to which we are accustomed because we are faced with maintaining substantial atmospheric forces while we develop the space capability. The result is that the current 'fixed budget' suddenly becomes totally inadequate. The question then becomes, 'How can we get more for our money, even if the present return seems adequate'."

Air Force feels the military-industry team must tighten its belt. Only the most promising and essential systems can be selected for operational use. The watchword for



MACH 3 VALKYRIE funding now totals $265 million. The program now looks like it will go. New problems in materials, aerodynamics, controls, navigation are all opened up by this aircraft. The entire aircraft industry will be stimulated by its development.

Long-range planners concerned over "cost squeeze"; Sophisticated weapons cannot continue to do old jobs

the military must be, "multiplicity of research, selectivity of development, and ultra-finite selectivity in weapon system choice". Air Force says industry must recognize this and meet the challenge with tighter management controls, better quality control and vastly increased system simplicity and reliability.

Beyond The Now — Feeling among the thinkers in Air Force long range planning runs high that we must find entirely new concepts or spend ourselves into economic chaos. We are in a cost squeeze. By new concepts, planners mean that we cannot continue to add new and highly sophisticated weapons to the classical methods of waging war. We can't build space planes to shoot down other space planes. We can't continue to build weapons to overpower other weapons.

Cost of current bombers is about 1½ to 2 times the cost of their immediate predecessors. The next generation of bombers will cost twice as much again. Missile costs coupled with related R&D, have reached multi-billion dollar proportions.

Initial costs are not the only concern. Cost of operating and maintaining new systems is also increasing. Cost to fly a B-47 for one hour is $500. It costs $1,300 per hour for a B-52. The B-70 figure has not been released but will no doubt at least double B-52 costs.

Fighter aircraft procurement is soaring too, F-80's cost $100,000 each, F-84 cost climbed to $300,000, then came F-100 at $750,000 each. Today tactical Air Command is getting its new F-105's at $1,500,000 a copy.

Trying to build cheaper weapons by simplifying them is fine for now, but it has limitations. Northrop tried this approach with the NATO fighter. It was designed to be a tailored weapon at minimum cost to achieve a desired task. The airplane wound up costing as much as the F-100, and this plane was not designed for economy.

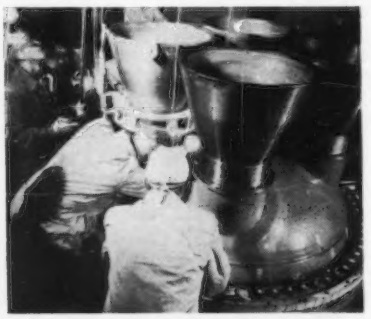
The need for new concepts is great. Air Force recently told a National Strategy Seminar that it is the greatest need which faces us. Changing of hardware is comparatively easy to changing of concepts. So, until fresh thinking comes into play in strategy, Tactical, Strategic, and Defense Commands will continue to shuffle, modify, and design new hardware for old jobs.

Research Program—Air Force budget for research, development, testing and evaluation is about $1.4 billion. Most of these funds are devoted to developing operational system for now and the near future. However, there is a strong feeling that military must support the nation's basic research as well. Air Force has some 1600 basic research contracts with laboratories, universities, and industries throughout the world. About $42 million will be spent this fiscal year exclusive of basic research done within Air Force. This is ten times the amount spent in the early 1950's. In the next few years, the basic research expenditures of Air Force should reach $80 million. There is a realization that the reservoir of basic knowledge is being used faster than it is being generated.

Areas being emphasized are: (1) propulsion chemistry, (2) super materials, (3) aeromechanics, (4) physics, (5) life sciences, (6) mathematics, (7) solid state mechanics. The latter, solid state mechanics, is opening many new areas of interest.

In applied research, Air Force is spending $243 million this year.

STRATEGIC AIR LIFT puts missiles, men, and equipment where Air Force wants them. The Douglas C-133 Cargomaster is latest aircraft to join MATS inventory. Lack of jet transports hampers MATS reaction time.



SOLID PROPELLANT Minuteman will become operational in 1962. Air Force claims certain cost and assembly breakthroughs in this program. As a result, Minuteman is cheaper per unit than other ICBM's and can be made by techniques as close to mass production as can be expected in this industry.

This sum is considered inadequate and allows exploration of only about 50 per cent of the technical opportunities available. The areas receiving attention are: (1) navigation, guidance, and control for aerospace vehicles, (2) pictorial sensing in radar and radar-like devices, (3) recovery of vehicles from orbit, (4) electronic miniaturization, (5) human factors, (6) a broad range of propulsion such as segmented solids, storable cryogenics, controlled nuclear explosions, ramjets, and general rocket technology.

Strategic Air Command—If war comes, SAC is responsible for delivery of more than 90 per cent of the Free World's striking power in TNT equivalents. Its most potent, manned weapons team is the combination of the B-52 Stratofortress and the KC-135 Stratotanker. The B-52G with two Hound Dogs and a normal nuclear payload is the most powerful bomber. The B-58 Hustler is the newest and will replace a portion of the B-47 fleet. Three wings of this Mach 2 aircraft are planned.

The B-52 inventory numbered 500 at the end of fiscal 1960. A new breed, the B-52H will start being delivered in early 1961. This model will continue to be an effective weapon through the mid 60's.

One of SAC's greatest problems is the need for guaranteed missile attack warning. None now exists. So SAC keeps its bombers dispersed and seeks funds for an airborne alert. Under the dispersal concept, no more than one wing of B-47's (45 aircraft) or 1 squadron of B-52's (15 aircraft) are allowed on any one base. The advantage of an airborne alert is that the possibility of the entire bomber force being destroyed on the ground is completely eliminated.

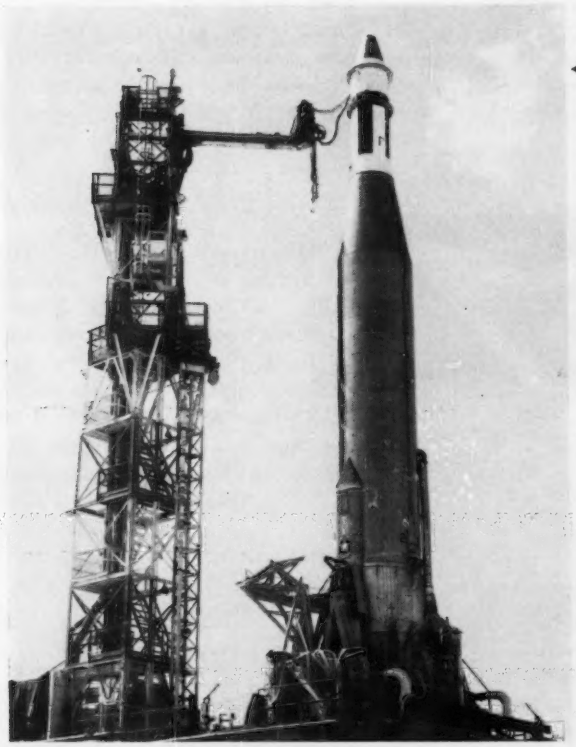
How does SAC Headquarters communicate with its bomber fleet and its coming generation of roving ICBM's?

The system is a near foolproof set of codes and communications procedures. A call on the famous "red telephone" puts one-third of the SAC force in the air in 15 min. A single-sideband radio known as "Short Order" transmits the special "go-code" signal if alert is real. Without this "go-code", aircraft hold short of assigned targets.

Messages can be relayed on 45,000 watt transmitters Underground Command Post at Offutt AFB or any of the three alternate Command Posts, Westover AFB, Barksdale AFB, March AFB.

An Airborne Command Post is provided, should the main Command Post at Offutt and all three alternate headquarters be destroyed simultaneously. Five KC-135 tankers have been converted by installing communications gear to control SAC weapons from the air. At least one of these Command Posts is always on 15 minute alert.

Follow On Weapons — Under development, as a follow-on to the B-52 is the B-70, a Mach 3 bomber with extended range and altitude. The project is getting new funding. The total is now $265 million. The Titan ICBM, incorporating several refinements over the Atlas, will join the SAC inventory in the near



◀ **MIDAS SATELLITE** will be placed in orbit by Atlas-Agena system. Midas will use infrared sensors to detect ICBM's shortly after they leave launch pad. Missile detection and warning is one of biggest problems Air Force faces.

SPACE EXPLORATION is proceeding rapidly in Air Force with the Discoverer satellites. Practically every phase of space flight short of manned control will be studied. Discoverer could make Mercury old before its time.

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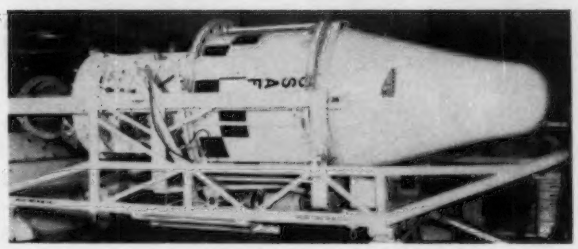

Tactical Air Command wants VTOL Mach 2 attacker; Transport Command hindered by lack of jet aircraft

future. Another missile planned for the 1960s is the Minuteman, a solid-fuel ICBM which will be highly simplified, cheaper to build, easier to maintain, and capable of almost immediate salvo launch once orders are received to fire.

SAC has begun testing and implementation of several tactics designed to guarantee survival of its ICBM force, even in the event of a surprise attack. They are, hardening of launch and control facilities and wide dispersal of missiles. In addition, with Minuteman, Air Force plans to place a portion of the force on railway launch cars. These cars can be moved constantly over the nation's existing railroad trackage to prevent the enemy from pinpointing their locations.

The Skybolt is being developed as SAC's first air-launched ballistic missile (ALBM). Carried by heavy bombers and launched 1000-mi from target, Skybolt will provide SAC with the most mobile strike force ever achieved.

The next step will be missiles like Minuteman and Skybolt with warheads that can be maneuvered in the terminal portion of the trajectory.

Tactical Air Command—A long time objective of Air Force has been a tactical, all-weather strike capability. F-105D brings this goal close to reality. Operating as part of a CASF (Composite Air Strike Force), F-105 will have global capabilities. CASF was developed a few years ago in an answer to the acute problem of "local wars". Composition of the CASF is normally squadrons of tactical fighters, reconnaissance units, aerial tankers, and troop carrying transports with sufficient supplies to sustain CASF for 30 days. CASFs reacted dramatically in Lebanon, and Taiwan.

An ambitious request of TAC is for a Mach 2 VTOL fighter-bomber. Some companies have undertaken design studies.
and warning is a crying need in air defense. Air Force has curtailed hardened SAGE sites and Bomarc interceptors to provide funds for acceleration of BMEWS, MIDAS, and SAMOS.

The first BMEWS site was recently completed in Greenland. Next year a second site will go into operation in Alaska. A third site will be placed in England.

BMEWS is effective for the immediate future. It will detect and accurately track in-bound warheads on ballistic trajectories following a general north to south course. But warning time and tracking capability is less than adequate for next generation of weapons. Warheads that would approach from the south, or warheads that could maneuver on the terminal part of their flight would escape BMEWS detection.

MIDAS (Missile Defense Alarm System) is intended to serve solely as an orbiting warning device. Carrying infrared sensors it is hoped MIDAS will detect missiles shortly after they leave the launch pad. The entire system is a fertile ground for new ideas and development work.

SAMOS is a reconnaissance satellite. It will transmit photos of the entire surface of Earth from its position in orbit. Accuracy the AF hopes to achieve in this system is described as "revolutionary".

Military Air Transport — The big mission of MATS is strategic airlift. This means moving military cargo and troops by air to any point on Earth. Since time is the key factor in defense planning today, MATS must react fast. Lack of jet transports currently hampers the overall mission. New funds have recently come available to rebuild MATS, and military markets for several types transport vehicles.

LAST BIG JUMP into space will come for Air Force with Dyna-Soar. First phase will see gliders dropped from B-52. Program will build to placing manned, maneuverable vehicles in orbit with Saturn booster.

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Army Tells Industry

Eight "Problem Guides" for industry give areas needing R&D;
Fertile minds urged to contribute possible solutions;
Turbine copter refinement needed to make ground forces "light-footed"

In the nuclear/aerospace age, the deterrent power of the U. S. Army pivots on mobility and flexibility.

The massive pre-invasion build-ups of W.W.II have already been relegated to textbooks on Military History. Concept of the pentomic army emphasizes packing a "big punch" into small elements deployable on a global basis on a moment's notice. Concentration of destructive power is no longer a problem, but its delivery is. Mobility, however, spells only one half of deterrent power, without the attribute of flexibility. Our commitments on a world-wide basis encompass areas running the gamut of climatic and terrain conditions. Flexibility aspects gain a new dimension when we consider the varieties of conflicts mankind has been capable of concocting during its short history. Briefly, then, the Army must be ready to meet a full spectrum of contingencies with a basic inventory at its disposal.

The soldier, however, as the basic element of military strength, cannot play his key role in all this unless he is supplemented by some

CHINOOK turbine-helicopter (mock-up) being loaded with transporter-erector-launcher for the Pershing.

IROQUOIS light turbine-helicopter may be used by the Army for command, liaison and observation purposes.

Army is interested in space primarily as it affects terrestrial warfare

of the seemingly most impossible equipment.

Army Problems Guide—Some of this "impossible" equipment is already in a process of materializing, but considerably more is needed to meet the challenges of the future. These challenges have been delineated by the Army into specific problem areas. A series of eight "Problem Guides" are now available. One of these is on supporting research and the rest cover each of the Army's technical services (Chemical, Engineers, Ordnance, Quartermaster, Signal, Medical Service, Transportation) outlining problems in R & D. Some Guides are classified, and only industries or activities with clearance can obtain them. They can be obtained through the Technical Liaison Office of the Chief of Army Research and Development or through the TLO of the Technical Service involved.

Principal reason for the publication of this information is to solicit ideas. The aerospace industries can find here fertile fields for idea development and possibly for diversification.

Of what nature are the Army's needs? They range from a heat-resistant elastomer which retains its properties at elevated temperature, to air-transportable pods for medical treatment and support facilities, and to new methods for increasing the flight safety of VTOL air vehicles.

The U. S. Army performs its mission with its feet lightly on the ground—in fact, on all kinds of ground. Nevertheless, it must be capable of traversing bodies of water, often with surface vehicles; it must also keep its guard up against intruders from the air, as well as take to the air for reconnaissance liaison, the rapid movement of troops and supplies, the evacuation of casualties, weaving its network of communications, etc.

Based on its missions and capabilities, the Army is also interested in developing communication satellites, mapping and geodesy satellites, a space surveillance system as well as an anti-satellite defense system, and an anti-missile system. Defense Department's ARPA recently turned over to the Army the $23 million Courier and the $174 million Advent communication satellite programs.

A further extrapolation of Army's role and interests into outer space may encompass operations on the land masses of celestial bodies as well. This extension of Army's role remains to be determined by technological, tactical and strategic considerations of the future. Army's interest in space is primarily directed toward the application of space to modern terrestrial warfare.

Coming closer to Earth in distance and in time, the Army now operates some 5000 to 6000 aircraft of fifteen types. It is estimated that by 1970 the total number of Army

LACROSSE is a highly-accurate guided missile intended for close tactical-support of ground troops.

◀ **PERSHING** is a two-stage, solid-propellant ballistic missile with inertial guidance. Its transporter-erector-launcher (TEL) allows operation on "shoot and scoot" principle.

aircraft will exceed 8000, but the variety will drop to about seven. The resulting logistical implications are obvious.

Command, Liaison and Observation—Army thinking about these missions favors the replacement of both airplanes and helicopter used now by some versatile, light turbine-helicopter. This is based on the assumption that rotary-wing state of the art will bring about a simplified helicopter with low-maintenance requirements within the next few years. Some problem areas associated with helicopters follow.

Needed are simple, rugged hub-assemblies, rotor systems for high speeds, collapsible rotor blades, hot-cycle rotors and tip jets for operation above 1200°F.

Powerplant needs include: quick-reaction overspeed governors for free turbines in shaft-turbine engines; high efficiency powerplant combinations such as turbine-rocket, a gas turbine within an annular ramjet, etc.; integrated lubrication systems and heat-exchange systems as part of airframe structure; radical improvements in air filtration systems for gas-turbine intakes; reliable methods for integrating electrical and electronic systems with the basic airframe; lightweight, long-life high-output batteries; crash-resistant fuel systems; engine noise reduction, etc.

Surveillance—For the immediate future, the Grumman AO-1 Mohawk, with a limited penetration capability (about 25 miles), seems to meet best the Army's needs. It carries self-sealing fuel tanks, light armor, and sensory equipment such as infrared, side-looking radar and cameras. The STOL characteristics of this aircraft make it particularly attractive from the Army's point of view. Estimates indicate some 250 Mohawks may be used by the Army by 1966. Target acquisition capabilities may be further supplemented by drone aircraft. Army's Transportation Corps foresees an additional mission for drones. It feels that a requirement exists for a drone capable of delivering one ton or more 200 to 300 miles and ejecting its podded supplies with circular possibility of error of 500 yards. Such a drone could drop a pod over the delivery point and return to base automatically, thus reducing pilot requirements and combat fatalities.

SS-11 wire-guided, anti-tank missile is launchable from ground or from helicopters.

◀**NIKE ZEUS** missile is being developed to provide a defense against the ICBM threat.

ARMY MISSILES

Missile	Type	Range	Status
Nike Zeus	Anti-Missile	—	Development
Pershing	Surf-to-Surf	500	Development
Nike Hercules	Surf-to-Air	—	Operational
Jupiter	IRBM	1500	Operational
Sergeant	Surf-to-Surf	75	Development
Corporal	Surf-to-Surf	75	Operational
Honest John	Surf-to-Surf	12	Operational
Little John	Surf-to-Surf	20	Operational
Missile "A"	Surf-to-Surf	20	Development
Lacrosse	Surf-to-Surf	20	Operational
Hawk	Surf-to-Air	—	Operational
Mauler	Surf-to-Air	—	Development
Redeye	Surf-to-Air	—	Development
Shillelagh	Surf-to-Surf	—	Development
Davy Crockett	Surf-to-Surf	—	Nearly Operational
SS-10, SS-11	Anti-Tank	3800 yds	Operational
Lobber	Supply	15	Development

Aerial Transportation—Army's concept of mobility, through the combat zone, is based on a flexible vehicle "mix." This would include Vertol's Chinook, Canadian de-Havilland's Caribou, a medium helicopter, and STOL transport. Current plans show an acquisition objective of over 300 Caribou and a comparable number of Chinook. The twin engine Caribou AC-1 will be able to lift 3 tons of supplies and equipment from an unimproved field less than 1000 ft long. Where true VTOL is required, the twin-turbine Chinook, the HC-1B will complement and complete the foreseeable transport-mission spectrum.

Utility/Tactical Transport — A single type of turbine helicopter is to fill the requirements of this mission. Army is phasing out the L-20, H-19, H-34, and H-21. Each future division will have the capabilities of moving at least one company of infantry anytime by its own organic means. The turbine helicopter will also perform battlefield evacuation. Some 2500 helicopters of this category are projected by 1970.

Flying Cranes—Army feels that this short-haul vehicle has applications at all levels throughout the combat zone. The biggest obstacle to the procurement of this "obstacle crosser" in greater numbers has been its high cost. However, Army also believes that the approaching state of feasibility of adequate-capacity and lower-cost, flying cranes would lower its "consumer resistance."

What About V/STOL's and GEM's?—By choosing the helicopter for the light observation aircraft, has the Army indicated a bias against more sophisticated concepts? An emphatic "No" comes from the Army on this score.

The censensus of the Army may well be reflected in the words of General Oakes, Deputy Chief of Staff for Military Operations.

"For the purpose of the Army, it makes little difference as to the shape and form of vertical lift, if the mission can be accomplished. We are not prejudiced against ducted-fans, convertiplanes, blowing jets, tilting rotors, tilting wings, or

Tri-Service VTOL research aimed to develop prototype of an operational transport for testing

indeed any particular flying machine including the helicopter. Our interest lies in giving the battlefield commander a vehicle that can do the job, is simple to maintain, easy to operate, does not have excessive POL requirements, and one which can be purchased in sufficient quantity to meet Army requirements under current budgetary limitations . . . We intend to maintain a strong research program in V/STOL to determine which year it would appear feasible to move into a specific development program . . . The success of this variety (V/STOL) of aircraft, however, has given a slightly false picture of their original purpose. These vehicles were strictly test-beds to generate basic data. They were not intended to be prototypes for pre-production work. There is still a great deal to be learned about such problems as downwash velocities, power requirements, control, complexity and maintenance requirements as applied to the battlefield environment. . . .

"The GEM has many interesting characteristics which hold future promise of military application. However, there are other characteristics which appear to complicate its application. . . . More power is required to control it than to lift it; there are many obstacles it cannot cross such as trees, ravines, steep slopes, etc.; dust (or spray) is excessive under some conditions. In summary, the GEM, from the Army view-point, is in its earliest research stage. . . . The Army is cooperating with the other services to explore these basic problems, but it is certainly much too early to predict just what place it will fill in future Army requirements. One application that looks particularly attractive is the 'over-the-beach' mission."

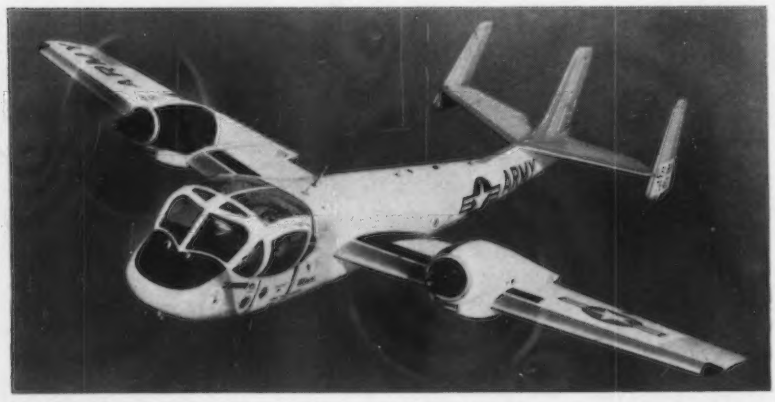
Specific V/STOL Problems—Nearly all current V/STOL aircraft have heavy propeller or rotor systems. Army stresses the need for weight reduction of these assemblies. It suggests further improvement of ducted propellers as a promising solution. Additional problems awaiting solution include: declutching systems for interconnected propellers; techniques for the reduction of downwash and re-ingestion; adequate methods of warning the pilot of low-flying aircraft of the approach to an uncontrollable flight condition; development of a jettisonable landing mat for V/STOL aircraft and helicopters to provide firm, stabilized, dust-free surfaces for landing and take-off in restricted areas; a lightweight, foolproof, and maintenance-free, in-flight hoisting system which is fast, auto-coupling, and reliable.

To adapt aircraft landing gear to rough terrain, a suggestion is also made for the use of the GEM principle. Engine mass flows may possibly be utilized to provide the required "air cushion" on landing and take-off, until sufficient forward speed is achieved for aerodynamic lift to become effective.

Tri-Service VTOL Research—On October 20, the Director of Research and Development, Dept. of the Army, and the Assistant Secretaries for Research and Development of Navy and Air Force announced the establishment of a joint tri-service program directed toward developing a prototype of an operational VTOL transport aircraft for suitability testing. The Navy has been designated to conduct this joint development program.

First step in this program will be the initiation of a design competition based on type specifications to be developed by Navy in coordination with Army and Air Force around the general characteristics recommended by the working group. The design competition will result in prototype VTOL aircraft which will be evaluated by agencies yet to be selected by the Military Departments. The program will be jointly and equally funded by the Army, Navy and Air Force over a four year period. The capabilities and counsel of NASA will be used whenever possible during the development program.

During the past several years, the Army, Navy and Air Force have conducted projects in the VTOL field that have produced "test bed" type vehicles such as the Army's McDonnell XV-1 (compound helicopter), Bell XV-3 (tilt rotors), Vertol VZ-2 (tilt wing), Ryan VZ-3 (deflected slipstream), Doak VZ-4 (rotating ducted fan),



MOHAWK, with its STOL characteristics, fulfills Army's aerial surveillance needs. It carries light armor and extensive sensory equipment.

Fairchild VZ-5 (vectored slipstream); the Navy's Kaman K-16 (combination deflected slipstream and tilt wing); and the Air Force's Ryan X-13 (vertical-jet tail-sitter), Bell X-14 (deflected vertical jet) and Hiller X-18 (tilt wing). Although these vehicles were strictly test and evaluation aircraft and were never produced in quantity, they have provided much technical information on the potential of VTOL aircraft.

Army Missile Program — The Army is being provided with a considerable array of missiles for its basic needs. This includes some already operational, others nearly operational, and some under development. Does this imply that all of the Army's needs in missiles, current and projected, are being fulfilled? A nominal answer to this question may evoke a "yes;" but wars are seldom, if ever, won by "nominal" appraisals of enemy capability.

Looming big on the Army's list of problems awaiting solution are those related to Nike-Zeus system, as part of ARPA's Defender program. Defender, with $412 million recommended in the 1961 budget, represents the concerted attack on the broad spectrum of defense against enemy missiles; the Army is entrusted with the development of the Nike-Zeus as an anti-ICBM missile. This problem affects the survival of all the Military Services, and ultimately that of the entire nation.

Crux of the problem is a very old one — target discrimination. This is the same type of basic uncertainty which has caused tragic mistakes in all wars, as it still claims scores of lives each hunting season. The problem of discriminating between re-entering ICBM warheads and possible decoys has been translated into some 250 contracts let to various research groups, universities, and to the industry. A recent announcement indicated an additional $199,125,000 was awarded for R&D on the Nike-Zeus program, leaving $137 million appropriated by Congress impounded. Army and others are convinced Nike-Zeus can hit and destroy its target, but as planned it does this on the downward part of the ballistic curve. This seriously limits reaction time. In project Defender ARPA is seeking ways to get better target information.

Second biggest problem related to Army missilery is mobility, from two aspects: the world-wide transportability concept, and from the battlefield dispersal view-point. Battlefield mobility, also influenced by the reaction time of the weapon system, is probably the best insurance against annihilation by counter-fire. The present generation of Army missiles, with solid-propellant engines are considerably more mobile, serviceable, and less hazardous to operate than the earlier liquid-propellant types. Nevertheless, considering the possible varieties of untractable terrain and climatic conditions encompassed by our military commitments, no missile system can be mobile, light, and rugged enough.

Additional attributes required of such weapons include: simplicity, high reliability under diverse battlefield conditions, adaptability to training programs, and optimum integration with supporting equipment.

The Ballistic Breed — Typical example of an improved second-generation missile is the Pershing, now in development stage. With its solid fuel, the Pershing cuts the supply problems associated with its predecessor — the Redstone. The Pershing will not require several of the heavy fuel-transporters the Redstone needs.

The Pershing is transportable by conventional cargo support aircraft and the Chinook, which, in addition to other missions, will provide battlefield mobility for this weapon system. It will be utilized in providing artillery fire support to the field Army. Using inertial guidance, the Pershing will direct itself onto a target some 300 miles unaffected by outside jamming. A new type transporter-erector-launcher (TEL) will facilitate transporting to a site, erecting, and firing within minutes. This will allow operation on the "shoot and scoot" principle.

Along with the Pershing, the Army is developing the lightweight rocket system, Little John to supplement the Honest John. This will maintain battlefield surface-to-surface effectiveness with a weight saving of about 70 per cent of the Honest John's weight.

In air defense, a noteworthy development is the Redeye, expected to be many times as effective as the .50 caliber machine gun. At a weight of 23 lb, Redeye is far more mobile in combat than the machine gun, which is 208 lb heavier. Redeye will fire an explosive warhead and have a "kill" potential many times superior to a machine gun against low flying aircraft.

Research & Development—Of the $40.9 billion expenditure for national security in 1961, about $9.4 billion is allocated to the Army. Of this, over $1.0 billion goes toward Army's total R&D activities. Estimates by the Aerospace Industries Association, for fiscal 1961 indicate that Army obligations for R&D on aircraft and related equipment is $36.6 million, and reaches $494.8 million for missiles.

In stressing the need for increased efforts and expenditures on military R&D as well as in procurement, Gen. Trudeau, Chief of Army R&D states: "We are very much concerned with the dimension of time in R&D . . . Money can buy many things, but it can't buy time . . . Presently, it takes some seven to eight years (in lead time) to deliver hardware to U. S. troops. This time covers R&D, testing and production . . . Soviet lead time is about five years . . . We must achieve a cycle of four years to keep obsolescence from undermining our new developments."

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POLARIS brought a new era to naval warfare, and raised Navy's standing as a fighting force. It has also brought the Navy new problems in navigation and communications. Navy has used this weapon system and its requirements as a stepping stone to space. The first loaded Polaris submarine began roaming the ocean depths on November 15, 1960.

Navy...

What They Have And What They Need

Prime mission of Navy is still protection of seas But weapons for the job cover the environment from ocean depths to outer space

Navy sees itself as protector of about 70 per cent of Earth's surface. This much is ocean area. Navy feels we, as a great maritime nation, must assure ourselves that we are never denied access to any portion of the open seas, on or below the surface. Guaranteeing this access is Navy's prime mission.

To perform this mission effectively, Navy holds that it must also control the air space above the seas. Control implies the discriminatory denial of access to ocean and airspace to an enemy aggressor. This means aircraft, missiles, and space vehicles must be developed to special naval tasks.

These weapons must seek out and destroy any enemy vehicle engaged in a hostile act. And here we come head-to-head with probably the greatest problem Navy faces—finding the hostile vehicles. Finding means first detecting the presence of a submarine, ship or aerospace vehicle, and second it means rapidly discriminating it from non-hostile vehicles. Whales must be sorted from submarines, 707's from Russian bombers, and "space junk" from long range missiles. This is not as simple as it might seem. In fact it is so complicated as to puzzle the greatest minds in the nation.

Polaris — Navy's weapons run the gamut from tactical to strategic, offensive and defensive. The biggest weapon at the moment is Polaris and its prowling nest—the nuclear submarine.

To do its job of putting 16 missiles on target, each submarine must know where it is at all times, where its target is, and when to launch. This opens up new problem areas for industry to solve in navigation and communications. How does a submerged submarine pinpoint its position? Polaris submarines now use inertial navigation called SINS (Ships Inertial Navigation System). This is a heavy, accurate adaptation of the Navaho missile inertial system. But this system uses gyros, and even our best gyros precess and cause navigational errors. Position checks must be made at frequent intervals using heavenly bodies, radio beacons, and topographic aids to recalibrate the gyros. "Polaris submarines are in good shape if a fix can be taken every 24 hr, but

ATTACK CARRIERS like the USS Saratoga shown launching two McDonnell F3H Demons simultaneously are an essential ingredient of Navy's limited war capability. Navy also plans several nuclear-powered carriers. Fighters, attack aircraft, and ASW planes are all a normal part of the carriers' complement of aircraft.

more frequent checks are desirable," Navy says. But none of the present references is entirely adequate. None provides a day or night, rain or shine availability. This has opened the door to space exploration for Navy. A navigational satellite system was needed and Navy proceeded to develop one.

Navy and Space—The Transit navigational system consists of 4 satellites in orbits which give complete global coverage. Extensions of the program are being considered to allow aircraft to use Transit for position checks.

And how does a submerged submarine communicate with a shore station, another submarine, or an aircraft? Present capabilities are quite limited. But Navy believes that space will provide an answer here too. Though Advent (the communication satellite program) is under Army direction, Navy has an extreme interest and is willing to contribute manpower, facilities, and money to its earliest success.

Another "space" system which has high Navy interest is SPASUR (Space Surveillance). It was developed as a direct result of the Minitrack network that was to track Vanguard. With Sputnik it became apparent that U. S. would have difficulty detecting and tracking noncooperating satellites. These satellites would not transmit on the frequencies available to tracking stations.

The SPASUR, or Dark Fence, system which grew out of this need consists of six stations in two groups, Eastern and Western. Each complex consists of two receiver stations separated by 500 nautical miles, with a CW transmitter located between the two. The network demonstrated a capability to predict Sputnik III positions 25 days into the future with an accuracy of 5 sec.

There is still a gap in the middle of the satellite detection fence across southern U. S. The gap is being filled by installing a central transmitter, and increasing the power of all transmitters. At present, the system can detect within several days any satellite passing over it. When the new transmitter is completed and the power is boosted, detection of any satellite passing over U. S. will be possible within hours. But Navy wants a better system.

Aircraft — All operational aircraft with the Navy have a capability for delivering conventional and nuclear weapons.

Manned aircraft have a place in Navy planning for the foreseeable future. Navy believes the aircraft has no equal as a weapon in limited war. It can search out the enemy, attack at long or close range, and survey the attack area for the feasibility of a follow-on attack.

Missions for Navy aircraft are: antisubmarine warfare, search and rescue, aircraft intercept, airborne assault, close air support to ground troops, tactical and strategic attack on ground targets.

In its attack aircraft, Navy looks for improved low altitude performance. This includes fire control equipment and radars that will give an all-weather capability. At present, the Grumman A2F-1 Intruder looks like the best vehicle for this. It includes a fire control system and instrumentation that are rake-offs from the Army-Navy Instrumentation Program (ANIP). Prime goal

Propulsion breakthrough overrides all other needs, Increase in efficiency of 100 per cent is goal

of this program is the integration of man with the complex machines of the aerospace age.

In fighter aircraft, Navy seeks long endurance, subsonic types equipped with long range missiles. The Eagle missile and the Missileer aircraft are the new generation here. In the more immediate future, McDonnell's F4H-1 Mach 2 fighter will go operational before the end of the year and will eventually replace the Chance Vought F8U-2 Crusader and its forerunner F3H, also a McDonnell design. By next summer, North American's A3J Vigilante will be operational. This aircraft has near Mach 2 capability and is touted as a high or low level attacker. It is seen as a backstop for SAC. Backing up SAC is a mission Navy does not talk about too loudly.

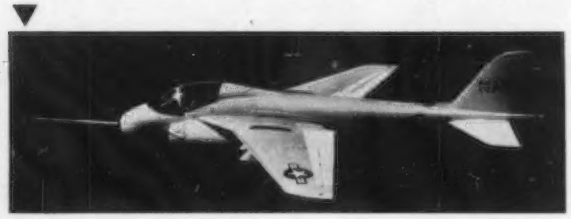
No aircraft are now on the draw-

WHICH SPACE SYSTEMS AID COMBAT SYSTEMS?

COMBAT SYSTEMS	INTERESTED SERVICE			SPACE SYSTEM							
	Army	Navy	Air Force	Weather	Geodetic	Communications	Navigation	Optical & Infra Red Reconnaisance	Infra Red Early Warning	Passive Electronic Countermeasures	Space Surveillance
STRAC	√			●		●		●	●	●	●
DEPLOYED ARMIES	√			●		●		●	●	●	●
AMPHIB	√	√		●		●	●	●	●	●	●
CARRIER STRIKE		√		●	●	●	●	●	●	●	●
POLARIS FBM		√		●	●	●	●	●	●		●
ASW		√		●		●	●	●	●	●	●
MINE WARFARE		√	√	●		●	●	●	●		●
AIR DEFENSE	√	√	√	●		●		●	●		●
MISSILE DEFENSE	√	√	√			●		●	●		●
TACTICAL AIR SUPPORT	√	√	√	●		●		●	●	●	●
STRATEGIC AIR			√	●	●	●	●	●	●	●	●
ICBM			√	●	●	●		●	●		●
IRBM			√	●	●	●		●	●		●

NAVY INTEREST in space systems is shown in combination with interests of other services. At left, checks indicate where each service has a peculiar interest in a combat system. Circles indicate which space systems can directly aid a combat system. Each service has an interest in practically all of the space systems. Navy does not feel this implies duplication. It points out that a reconnaissance satellite designed by Army or Air Force for surveillance of land masses may be inadequate to survey shipping. Source: Navy testimony before U. S. House of Representatives, Review of the Space Program, February 9, 1960.

ATTACK AIRCRAFT Navy seeks must have good low altitude performance and all-weather capability. Grumman's A2F-1 Intruder is probably best of latest crop. Intruder has fire control and navigation system which bear the fruits of ANIP (A&M August, 1960).



LATEST FIGHTER McDonnell's F4H Phantom II, will soon be operational. Navy recently awarded $109 million for additional procurement. No aircraft is on the drawing boards to replace this Mach 2 interceptor.

ing board to replace F4H or A3J. No aircraft is on the drawing board to replace Martin's P5M seaplane. Mach 2 fighters and the present seaplanes seem to be the end of the line for their types.

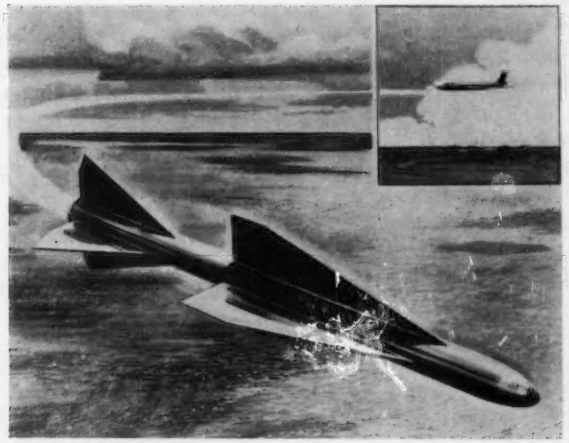
Increased emphasis is going into antisubmarine warfare. The aircraft plays a dominant role in this mission. Grumman's S2F-3 will extend mission time of present aircraft by over 2 hours. The aircraft will be equipped with Jezebel detection gear, Navy's latest. About 7250 sq mi of sea area can be searched by this aircraft in one hour. Navy will not disclose depth of search, but it is reported to be over 100 ft. The highly classified Jezebel system is a type of passive sonobuoy, it listens for submarine noise and transmits its findings by radio to aircraft which dropped it.

Lockheed's P3V (Navy version of Electra) will also reinforce the ASW mission. This aircraft will have the capability of proceeding to a station 1000 mi distant and holding for 10 hr with safe return to base.

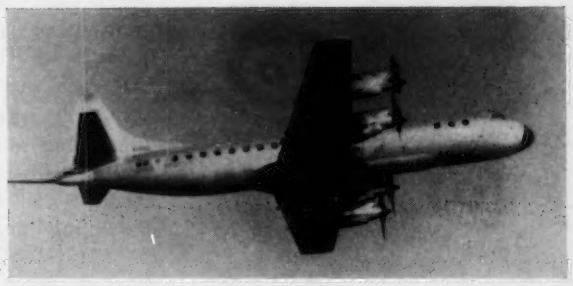
Helicopters like Sikorsky's H SS-2 and Vertol's YHC-1B are planned for ASW work using the SONAR dip technique. Helicopter will hover, dip SONAR gear, proceed to another area, dip again, and zero on submerged vessels by triangulation.

Vertical and short takeoff aircraft are most attractive for missions like support of ground forces and operations ashore. Present plans call for Navy to develop a prototype VTOL transport for evaluation and test as a joint program with Army and Air Force.

Exploratory development work is underway on various Ground Effect Machines (GEMs). A small 20-ft experimental boat recently rode the Potomac River on a cushion of air sealed under the vehicle



LATEST AIR-TO-AIR missile for long range defense of land and sea targets is Eagle. The missile is to be launched from a subsonic aircraft called Missileer. Target discrimination will be a big problem for intercepts in excess of 30 mi.



LONG RANGE P3V-1 is conversion of Lockheed Electra. It will augment carrier based aircraft for ASW. P3V can proceed 1000 mi to sea, patrol for 10 hr, and return to base. Lockheed recently received $53 million for follow-on production.

ANTI SUBMARINE WARFARE is a top Navy mission. It is also one of Navy's biggest problem areas. The Grumman S2F-3, shown, will carry latest electronic gear for ASW. Julie and Jezebel systems are two of newest concepts. Julie uses "Explosive Echo Ranging," Jezebel is a highly classified "passive sonobouy-type" system.

AIRBORNE EARLY WARNING is necessary to successfully intercept and destroy high Mach aircraft. Grumman's W2F-1 Hawkeye is latest carrier based aircraft of this category. It uses Airborne Tactical Data System (ATDS) as a "nerve center" to collect, store, and collate intercept data.

Companies interested in aiding Navy research can get classified "problems guide" from Sec Navy

by a water curtain. This and other similar prototypes give great promise for high speed water transport.

Missiles—Navy plans to replace guns with missiles on its surface ships. Surface-to-air missiles are receiving heavy funding to provide defense against the air-to-surface attack. The funding will increase in the next decade. Navy has asked for immediate increases in these areas:

	Million
Typhoon (Long Range)	$11,800
(Medium Range)	14,400
Eagle	4,067
Tartar/Talos	1,050
Sidewinder 1-C	2,000
Bullpup	2,000
Guidance, fine control, propulsion, propellants	20,625
Pacific Missile Range	19,216
Total New Funds Needed	$75,158

Big Breakthrough—Navy feels, "the biggest shortcoming in true space exploration is the propulsion barrier. With chemical propellants it is not possible to exploit the planets or build deep-space maneuvering weapon systems. It is possible to get scientific missions to the Moon, but not practical weapon systems or commercial endeavors. A breakthrough in propulsion efficiencies in the order of 100 times over that theoretically obtainable with chemical propellants is an R&D area transcending all others in space."

The Research Effort—The flurry of activity in seeking new and better ways to perform mission tasks is evidenced by the size of the research and development budget. Over half of the money the country has spent on R&D in its history has been spent in the last ten years.

Navy's part of the current $4 billion R&D budget is $1.3 billion. Basic research is carried out by the Office of Naval Research (ONR). About 1800 contracts are outstanding, only 40 of these are classified. Applied research and development is conducted primarily by the technical bureaus within Navy, i.e., Bu Weapons, Bu Ships, etc. ONR engages in this only to a small extent. The work is carried on in response to the requirements of the Chief of Naval Operations (CNO).

Design and development are carried out exclusively by the bureaus either by contract with industry or by work projects at Navy laboratories and field activities. These bureaus are also responsible for the test and evaluation of equipment produced by the contractors or Navy field activities.

Doing Business — Navy wants industry to know about naval problems. They recognize the oneness of combat readiness and a technical community well informed on operational problems. However, paralleling the desire for an informed industry is a desire to prevent a potential enemy from learning too much about the scope and limitations of its best equipment.

Firms and individuals who have a capacity for engaging in research that will contribute to the national effort can receive Navy's "Problems Guide For Industry" by complying with OPNAV Instruction 5500.33. Copies of this instruction can be obtained from the Office of Chief of Naval Operations, Washington 25, D. C. Formal subject title of the instruction is Department of the Navy Long Range Scientific and Technical Planning Program.

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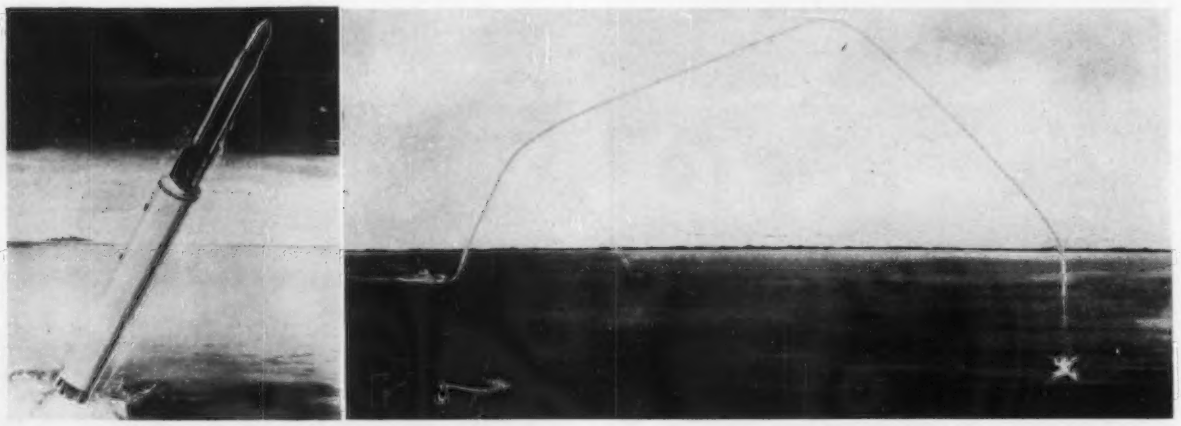


SUBROC MISSILE-TORPEDO is an underwater-to-underwater weapon for submarine combat. Navy knows it has a relatively invulnerable weapon in Polaris and is now working hard to find a way to combat its own system, looking to the day an enemy might have missile-bearing nuclear submarines.

Space . . . Military Moves In

Air Force seeks funds for winged Spaceplane and manned Orbiting Command Post . . . SAC to control; Radical change in weapon planning foreseen by Gen. Richardson

It is progressively difficult these days to find anyone who in conscience denies that in the great reaches of space lie additional means of foolproofing America against attack.

Realizing this, and in keeping with the security phase of its mission, Air Force is taking two major steps toward assuring that we will not be caught sitting here, earthbound, looking up at some other nation's space force.

At least two major space weapon systems have come beyond the "thinking about" stage for incorporation into Strategic Air Command's arsenal.

1. A manned, self-powered, maneuverable Spaceplane is in the works. Funds will be requested for full go ahead in fiscal 1962 budget.

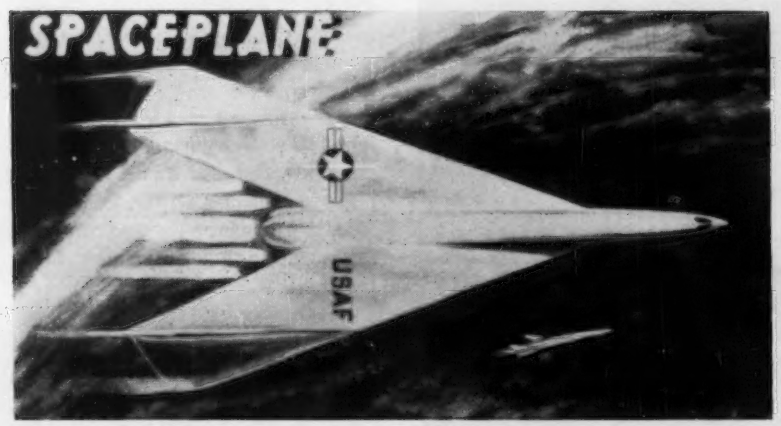
2. Qualitative operational requirements have been prepared for a feasibility study for an orbiting command post able to penetrate into deep space, give early warning direction, provide reconnaissance and, if war ever came, direct offensive and defensive operations.

In addition, Air Force will vigorously seek an "agonizing reappraisal" of our national security posture—will try to convince the administration and the public that entire new concepts of strategy are needed to accommodate new space weapons.

Spaceplane — The Spaceplane would take off as a winged aircraft, orbit in near-space (200 to 300 mi up) and land under aerodynamic pilot-control. As presently conceived, the plane probably would use liquid oxygen in the propellant.

The plane would compress and store the oxygen, renewing the fuel supply by dipping down at Mach 15+ from maximum altitude to the Earth's outer atmosphere and then reattain space altitude at will. However, other potential propulsion systems, such as engines using ion and plasma energy, are not being overlooked. Many such propulsion studies are explored in Project Hare.

Initial design requirements for the space craft were drawn to provide what Air Force believes is a vital tool for the deterrence arsenal of SAC. The project now is in the hands of the Ballistic Missile Division of USAF's Air Research and Development Command. BMD



INITIAL DESIGN work for Air Force Spaceplane is well underway. Craft would take off aerodynamically, fly to orbit 200 to 300 mi beyond Earth, and land with aerodynamic controls. Liquid oxygen for propellant system would be replenished by dipping into atmosphere at Mach 15, scooping-up and compressing loosely associated molecules. Convair, North American, and Lockheed are reported working on Spaceplane project. Early artist concept is shown.

Air Force wants vehicle which can "fly" into orbit; Last missile for man-in-space on design boards

is talking to Department of Defense and to private contractors about preliminary proposals.

Dyna Soar Follow-on — Air Force feels that the Spaceplane, thus far called in the specs simply an "aerospace vehicle," would be a practical and economical step beyond the Dyna Soar skip-glider, now scheduled to be aloft within three years, because the plane would carry a multi-man crew and, importantly, not depend for launching on expensive, non-reusable ballistic boosters.

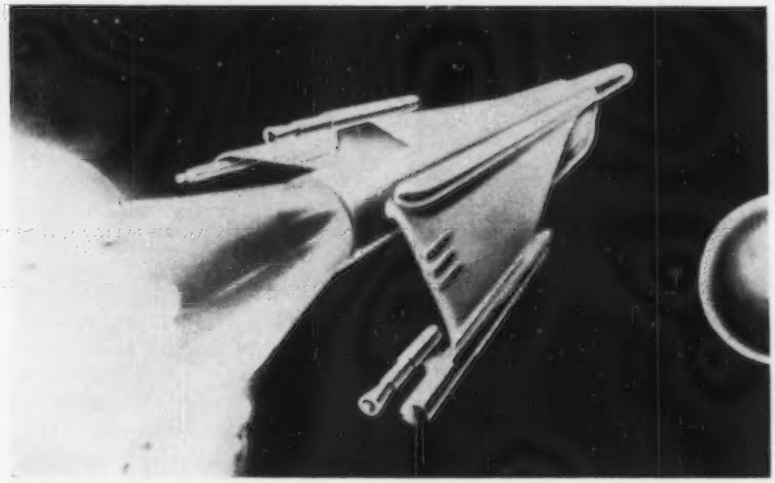
Ground environment, or what it takes to prepare and get a ballistic missile aloft, represents 80 to 85 per cent of current costs. By using existing runways for takeoffs and landings, the projected Spaceplane could bring obvious economies.

It should be noted that cost estimates on the Atlas, thus far the chief weapon in SAC's missile inventory, run from $12,000,000 to $16,000,000 per vehicle, depending on who makes the estimate and where his sympathies lie.

The Timing—Spaceplane could be operational by 1970, in keeping with the classic time lag between conception and completion of air weaponry. The command post might be aloft by 1975-80, depending on funding and on the urgency given the project by ARDC, the Defense Department and the new Congress.

As for the command post, space-thinkers have little doubt that it could be placed in orbit by the family of launch vehicles now coming along. Such boosters will, by 1967 or before, be able to lift payloads of more than 50,000 pounds —in dramatic contrast with only 150 pounds in 1959!

Both projects conform with Air Force's desire for a continued "mix" of deterrence weapons, manned and unmanned, and with the belief that in the extraterrestrial realm of space may lie the key to national survivability.



ARTIST CONCEPT of advanced Spaceplane shows several types of powerplants. Super-fueled turbines have been proposed for atmospheric maneuvering, hypersonic flight in the far atmosphere might be with hydrogen ramjets. Space power would be by a conventional rocket burning liquefied oxygen collected from the atmosphere.

Not long ago, General Thomas S. Power, commander of SAC, said in addressing the American Legion's National Security Commission on the subject of manned spacecraft:

"Their purpose would be threefold—to provide instant warning of any act of aggression, to intercept hostile missiles and spacecraft and, above all, to deter aggressors."

The NASA Bugaboo—It now remains to be seen whether the two projects can pass muster with the National Aeronautics and Space Administration, the civilian-dominated agency which evaluates space projects as to whether they are strictly military or will further the interests of scientific and peaceful exploration.

Asked whether he felt the two Air Force projects might be vetoed by NASA's space monitors, one air officer said testily, "Hell, we're in space right now. Where do you think the Atlas travels — under ground?"

Air Force Speed Up—The need for a crash program on nuclear propulsion, perhaps akin to the Manhattan Project for the atomic bomb, also is expected to be pushed by Air Force. Unless NASA's timetable is stepped up, the first flight test of a nuclear second-stage rocket will not be accomplished until 1965. Nuclear propulsion, under present thinking, is viewed as important for maneuverability and duration in far orbit rather than for initial thrust. The Air Force command post, for instance, could remain in orbit and function indefinitely on nuclear power, being serviced with manpower and supplies by a satellite shuttle operation from Earth.

Such a mid-space operation was discussed as recently as a month ago by Major General Don R. Ostrander, who represents the Air Force in NASA's top echelon. Ostrander, addressing a propulsion forum at San Antonio, Texas, speculated on several of what he called "wild blue yonder" energy systems, saying:

"Another unique concept involves the use of Earth's atmosphere

itself as a propellant. Fantastic as it may seem, it might be possible to employ a satellite orbiting Earth at low altitudes to collect and condense the very thin air which exists in the upper reaches of the atmosphere.

"The collected air could then be liquefied and used as an oxidant, or it could be used as the propellant working fluid in an electrical engine.

"The satellite could then act as a refueling station for a low thrust spacecraft that would rendezvous, refuel and continue on into space. This, of course, involves such neat tricks as reducing the size of the liquid oxygen plant, which in a ground-based version weighs thousands of tons, to a weight and size that can be carried in a space vehicle.

"A somewhat similar scheme involves collecting ionized gases in space. At higher orbital altitudes, we find gases such as O_2 highly ionized by energy from the Sun. On recombination, these ions would furnish not only a working fluid, but significantly amounts of energy from their recombination.

"A number of people have also suggested the fuel-from-rock concept; that is, extraction of water from lunar or planetary rock with further breakdown of the water into oxygen and hydrogen through the use of nuclear or solar energy."

Air Force's SAC, as part of its space planning, currently is accelerating its aeromedicine and human capabilities research, striving to adapt existing skills and experiences as much as possible. This is done on the assumption that when and if America has a deterrent space force in strength, the force would logically function within SAC as a natural progression of SAC's mission of preserving peace through strength. Setting up an independent space force, as such, would be both expensive and unnecessary, the men at SAC are convinced.

A Place for Man—Air Force spokesmen say that regardless of instrument sophistication, there still is no complete substitute for human decision and evaluation. Many manufacturers have come forward with dream plans for unmanned, missile-boosted craft and been told to go back to their airframe-design engineers and return with plans providing for "men, maneuverability and recoverability." Convair, it is understood, did just that and may therefore be the frontrunner in the Spaceplane race.

Concerning this complexion of the Air Force of the future, agreement is by no means unanimous but there are military strategists who are convinced that the last basic ballistic missile system has now been developed and, henceforth, emphasis must be placed on manned vehicles with self-contained propulsive systems and reentry capability.

"It is not likely," General Power has said, "that there will ever be a complete substitute for man's reasoning power. It is that uncanny capacity which will always be needed over enemy territory to deal with unpredicable problems."

As Lieutenant General Roscoe C. Wilson, deputy chief of staff (development) for the Air Force, puts it:

"ICBM's, even though they become more sophisticated, will remain stupid brutes. Only a manned vehicle can provide the flexibility and finesse so vital to victory in military operations."

To this is added the comment of George M. Low, chief of NASA's Manned Space Flight Division. "Under the assumption that Project Mercury will demonstrate that man can indeed perform useful functions in space, we believe that in all future missions the primary control should be onboard."

The Facts of Life—Meanwhile, on the subject of how far the Air Force will be permitted to go with its space program, a grey area of jurisdictional doubt exists between "survivability thinkers" and the science-only advocates. The military feels, as one general officer states it, that NASA "lacks a sense of urgency; they have a different psychology entirely; they don't admit the facts of life."

NASA came into being October 1, 1958, after President Eisenhower signed an act of Congress creating the agency. The act clearly stated, "It is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of mankind."

Then the act went on to define the scope of NASA's activities: to expand human knowledge of space, to develop space vehicles, to sponsor long-range studies, cooperate on research with other nations, and avoid duplication of effort and equipment.

But while stipulating that aeronautical and space activities shall be directed by the civilian agency, the act exempted from NASA control "activities peculiar to or primarily associated with the development of weapons, military operations or the defense of the United States." Further, the law states that discoveries possessing military value or significance should be made available to defense agencies.

It thus is not assumed, says the military, that America will be prohibited from having defensive and offensive systems in space. It is here that an area of dispute occurs.

Space is For . . . ?—Reflective of military feeling was action taken at this year's Air Force Association convention in San Francisco, "National security," said a resolution submitted by the association's board of directors, "requires a candid acceptance of the space arena as a potential theater of operations in cold and hot war."

The resolution, which passed unanimously, called upon President Eisenhower "clearly to enunciate the existence of the military mission in space and to designate the Air Force as the responsible military agency to carry out the mission." Further, the association urged Congress to enact legislation providing for an "active, continuing high-priority program looking toward the execution of military operations in space."

Civilian spokesmen have not

Can military protect space for peace with conceptual and hardware rakeoffs from NASA

been quiet, either. For instance, Dr. George R. Arthur, a General Electric scientist who is president of the American Astronautical Society, says that space and defense are irrevocably tied together and any attempt to isolate them from each other is "artificial, even naive."

"The technological problems to be bridged in scientific space exploration are the same as those for establishment of military posture in space," Dr. Arthur argues. "The United States has tremendous scientific and technical potential, possibly still the world's greatest. We must not diminish this potential by a conservative approach, by penny-pinching or squandering our resources, or by squabbling over who does what."

Apollo and Military — While there has been no open break between the military and NASA, conflicts do occur. To illustrate, U. S. Congressman Overton Brooks of Louisiana, chairman of the House Committee on Science and Astronautics, has detected what he calls certain evidence of overlapping of effort. He was referring specifically to NASA's Project Apollo, which is a follow-on program to Mercury and calls for a manned vehicle "designed to allow man to perform useful functions in space."

Apollo's frame of reference contains what appear to be duplications of some military endeavors.

"The design of this spacecraft (Apollo)," NASA has announced, "should be sufficiently flexible to permit its use as an earth-orbiting laboratory, as a necessary intermediate step toward establishment of a permanent manned space station.

"In this decade, our planning calls for development and construction of an advanced manned spacecraft with sufficient flexibility to be capable of both circumlunar flight and useful earth-orbital missions. In the long range, this spacecraft should lead toward manned landings on the moon and planets, and toward a permanent manned space station."

NASA, according to Dr. Hugh L. Dryden, deputy administrator, is planning the first Apollo launching "in the 1965-67 time period." Individual feasibility studies are being done by Convair, Martin and GE's Missile and Space Vehicle Dept.

At the moment, however, most of NASA's funds for manned space flight are earmarked for Project Mercury—$87,000,000 in the 1960 fiscal year and almost $107,000,000 for 1961. NASA hopes that in the 1962 fiscal year a contract can be initiated for the design, engineering and fabrication of a complete spacecraft system.

Where NASA Gets Boosters— Those who insist it is impossible to separate space from military necessity point out that the X-15 rocket-powered plane is launched from a B-52 bomber, hardly a non-military machine; also, the X-15 pilots come not only from the NASA manpower pool but from the Air Force and Navy.

Further, the rocket types now cocked and ready at SAC installations serve a deterrent purpose on one hand and, on the other, are used by NASA in space probes. NASA also has contracts with the same industrial firms that serve the military as both prime and subcontractors.

The military was not exactly happy when, this year, NASA took over, by presidential directive, development operations of the Army's ballistic missile agency at Redstone Arsenal in Huntsville, Ala., now renamed the George C. Marshall Space Flight Center. Maj. Gen. J. B. Medaris has said, "there is so little difference between civilian and military space programs that there is no justification for their division." He resigned in protest over the way the missile-space program was being managed.

With the Redstone takeover went work on Saturn, the 1.5-million-pound thrust rocket designed to circumnavigate the moon and to put a 25,000-pound space laboratory into earth orbit.

MANNED ORBITING COMMAND POST could be put into space in the 1975-80 time period, depending on urgency given to project by ARDC, DOD, and the new Congress. Strategic Air Command would direct offensive and defensive operations from this post. Concept is an extension of taking command post aloft in converted KC-135 aircraft.

Acting fast, and in depth, NASA created at Huntsville an Office of Launch Vehicle Development and realigned other major divisions such as the Office of Space Flight Programs, the Office of Advanced Research Programs, the Office of Business Administration and the Office of Life Sciences Programs.

NASA And Life Sciences—NASA, which has better than 29,000 persons on its payroll, also has moved in on the military at such research centers as Langley Air Force Base, Moffett Naval Air Station, Edwards Air Force Base, and Plum Creek Ordnance Works.

Such endeavors were bound to irritate the military. Nor, to continue, did the Air Force cry out with delight when NASA took over Project Mercury, on which Air Force life-sciences people had spent more than 30,000 man hours and had worked with General Electric and North American Aviation on preliminary mockups—only, by the way, to have McDonnell Aircraft get the final contract.

NASA's awareness of the friction is reflected in its recommendation to the last Congress that an Office of Life Sciences be set up within NASA to help the agency "discharge its biomedical responsibilities" and, among other things, negotiate "satisfactory working agreements with other government agencies and the military services."

"Somewhat paradoxically," the report to Congress said, "NASA, which does have a clearly defined mission to put and maintain men in space, has essentially no existing capability for studying the biological and medical problems involved. Faced with the necessity for selecting a group of astronauts for Project Mercury and providing for their safety during this series of missions, the agency turned for assistance to the armed services.

"The services, in turn, have responded with enthusiasm and goodwill toward this new challenge. In spite of the apparent success of the arrangement, the fact remains that authority for ensuring the health, safety and effective functioning of the astronauts is not firmly in the hands of the agency responsible for the success of the project as a whole.

"The medical personnel were not selected by NASA but by representatives of the military services, which provided them on a loan basis for this particular task. Their continued presence in the project is as much a matter of continuing goodwill as it is a clear contractual agreement, and the individuals themselves must of necessity feel a primary loyalty to the services in which they have elected to devote their entire careers."

NASA also has taken a potshot at the human centrifuge, for simulating space problems, which the Navy built and operates at Johnsville, Pa., and which NASA says duplicates other centrifuge facilities such as, perhaps, NASA equipment at Ames Research Center. NASA states that such a facility (the one at Johnsville) "could be held and operated by a NASA interservice committee with a budget provided by one or more of the services represented on the committee."

And so the problem of cross-purposes remains.

Despite this, USAF realists are pursuing their assignment, as described by General Thomas D. White, chief of staff:

"To assure that our weapons and supporting systems are at all times modern and capable of optimum mission performance, a strong and virile research and development program is mandatory."

General Power (SAC) not long ago made this prediction:

"As air supremacy meant control of the battleground beneath in World War II, control of space may well mean control of the globe in a future war. Whether we like it or not (conquest of space) is still primarily a question of survival."

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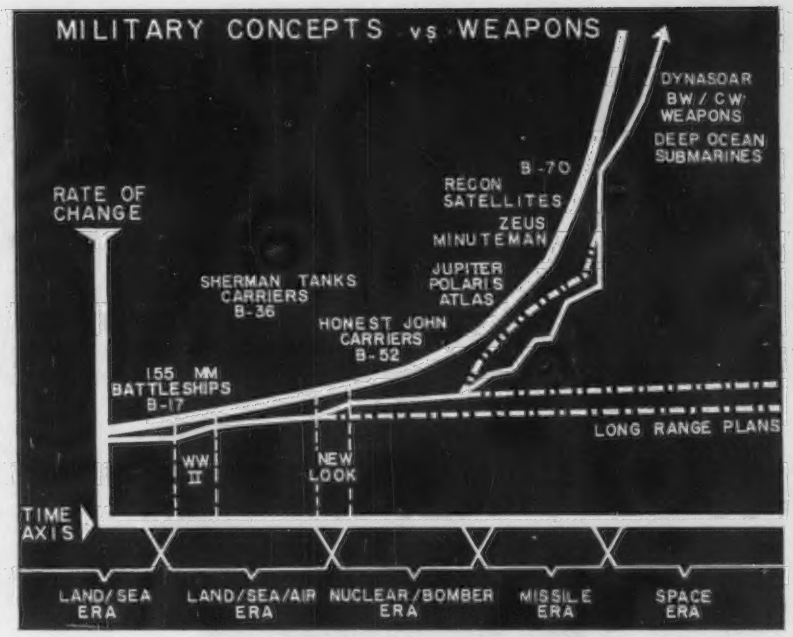

PLANNING LAG is shown in chart taken from National Strategy Seminar talk delivered by Brig. Gen. Robert C. Richardson III, USAF Long Range Objectives Group. Weapons have outstripped planning concepts. Richardson advocates an R&D approach in developing new strategies for space age.

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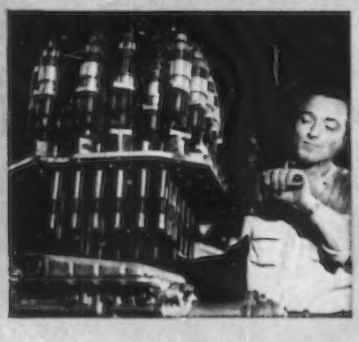

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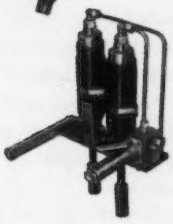

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Spin Forging And The Ramjet

Bomarc rejuvenation aids new metalworking process
Marquardt forms engine parts on huge Hufford machine,
Seeks to marry explosive forming to spin forging

By Philip Geddes

A 60-in. Hufford spin forge is in production use at Marquardt Corporation's Ogden, Utah, assembly plant. It was installed under the Air Force's heavy press program. As with many new machine tools, there have been problems. Certain mechanical defects in the design of the machine had to be ironed out but the users say they have complete confidence that the mechanical abilities claimed are realistic.

The Hufford press "is the first big equipment without the mistakes of most big verticals. It is heavy enough to withstand working loads, and has enough force to form the newer materials which need higher forming pressures."

After the shakedown period, the optimistic opinion that you can

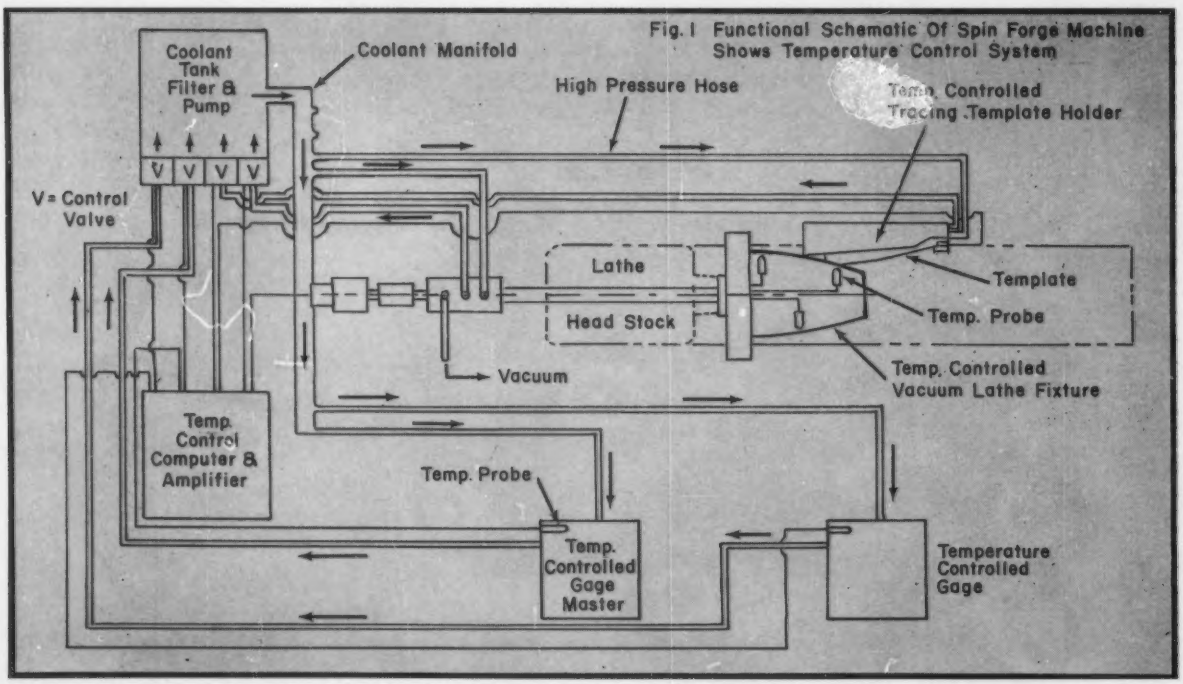


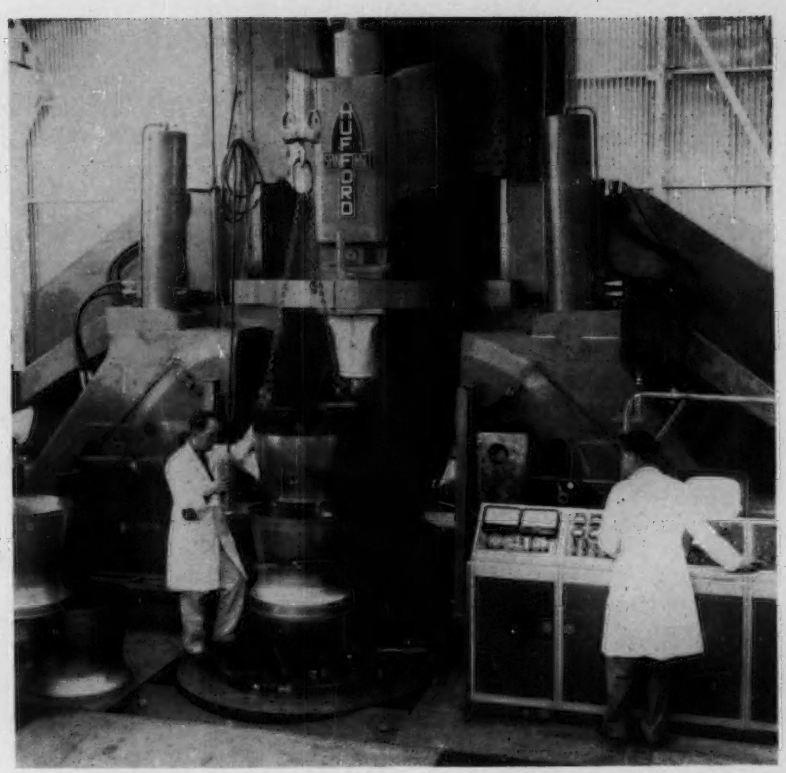
Fig. 1 Functional Schematic Of Spin Forge Machine Shows Temperature Control System

"spin-form to any shape" had to be revised somewhat to suit production facts. "There is a time to forge and a time not to. Although the machine will always distribute metal infinitely better than anything before. After spin forging basic shapes, drawing and explosive forming can supplement the forge to produce reasonably priced parts."

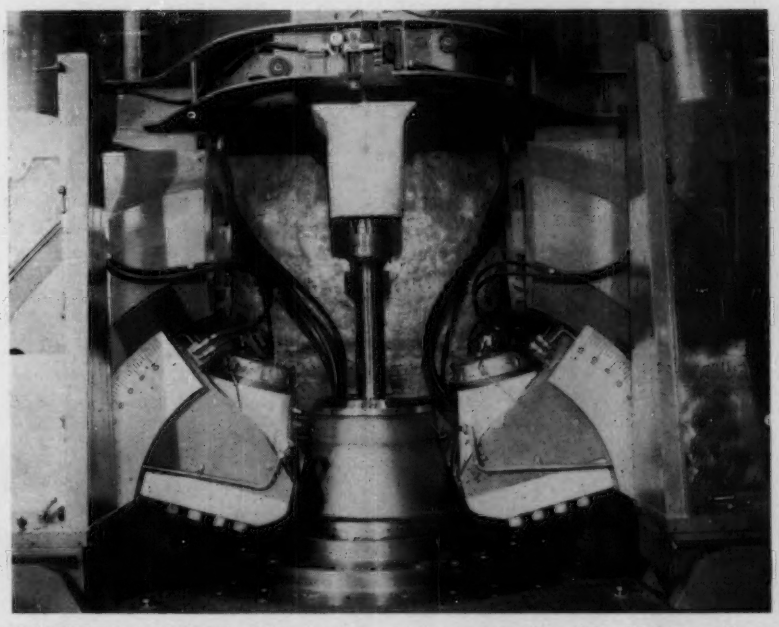
Spin Forge In Action—The 310 stainless steel combustion-chamber exit nozzle shown in Fig. 1, was originally made by weld assembling two formed sheet metal weldments. The outside walls were then finished machined to obtain required variable wall thickness. Each of the two original weldments was made by a combination of separate operations involving shearing rolling, welding, and expanding mandrel work. The manufacturing sequence required one circumferential and two longitudinal welds. There was extensive waste from fabricating the two weldments and extensive outside finish contour machining.

This ram jet part is now made in two spin forge operations from an explosive formed venturi shaped preform. The first spin forge operation forms the part from the throat area down, the second from the throat area up. Access to the throat area by the forming tool rings is gained by adjusting the angle of the tool ring heads. The preform is cold formed in a female die by explosive forming. The combination forming methods for making the exit nozzle cut production time from 18½ hr. to 3½ hr. Over-all production cost is reduced 81 per cent.

Marquardt Opinions—Marquardt feels "The next logical step in manufacturing parts like the exit nozzle is to reverse the process by spin forging a preform which can be explosive formed to the final configuration. This step would demonstrate the complete adaptability of the spin forge as a machine tool capable of producing preforms or finished components." Initial work along these lines with smaller parts has been achieved. Marquardt also says quite simply that spin forging is in its infancy.



THE MACHINE Marquardt uses in spin forging parts for Bomarc ramjets is made by Hufford. Split mandrel is shown being separated to remove a complete part.



ON THE MANDREL, 310 stainless steel part is reduced in thickness about 73 per cent in one pass. Actual machine running time is about 4 min and no finish machining is necessary except trim.

Marquardt keeps production parts at constant temperature while room temperature varies from 65 to 110°F

Temperature Compensation—The ramjet plant at Ogden is not air conditioned. Summer temperatures range from 65 to 110°F. With many magnesium parts used on the Bomarc ramjets in production, this temperature drift adds to machine shop problem of holding tight tolerances. In assembly, tolerance buildup across an engine can affect interchangeability of parts.

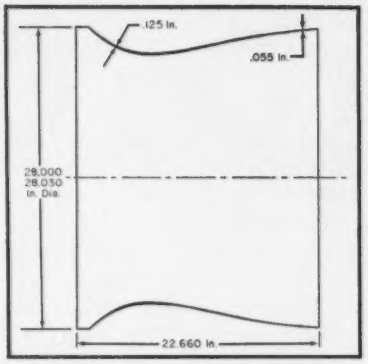
If tool, tool master, and part in production could be held at one temperature it would be vastly superior to air conditioning the machine shop . . . ignoring personnel comfort. A combination of good machine sense and electronics provided the solution at reasonable cost. Standard parts were used costing less than $2,000 per set up.

The ratio bridge is a simple sensitive sensing device in which each leg of the bridge performs independently. Such bridges form the basic circuit of many temperature sensing systems where several readings are required to control an area. A bridge circuit forms the basis for the Marquardt machining temperature control circuit.

In a typical lathe setup, the temperature sensitive legs of the bridge are installed as follows (Fig. 2): One in the holding tool; (2) One in the working tracer template one in working gage; and (3) one in the gage master.

More than four legs can be handled. Each temperature controlled part is connected to a common refrigerated cooling fluid source through a control valve and lines. Unbalance in any leg or legs of the bridge is sensed in a control amplifier. The appropriate control valve opens and cooling fluid flows under pressure through the hot part until the unbalance is corrected.

Holding Fixture—The machine tools must be adapted to use the system in a manner similar to Fig. 3. Holding fixtures mount on the lathe face plate to correspond with the built-in cooling and vacuum chucking holes. Cooling fluid, therefore, can pass through the revolving fixtures as called for by the temperature probe there. The part illustrated is a cowling lip made from a magnesium sand casting with 0.090 in. walls, approximately 26-in. long. Part is held in master to find center, then rough trace turned on the inside. The outside is turned in a similar manner on the appropriate male fixture. The large end and inside diameter can then be finished. Since wall diameter is critical, final machining the cowl lip is not started until the finished inside diameter is coated evenly with a layer of polyethylene - glycol (carbo-wax melt point 145°F) on a special fixture. The machinist can then be sure that when the final outside cut is made that the part is mounted as near to center as is practical. This sequence of operations with automatic constant temperature control, guarantees wall thickness to a degree impossible beforehand in the same time. The machinist works with a go-no-go gage (at a constant temperature of 72°F) instead of fighting ±0.002 in. on a large diameter.



THE PART in production on the Hufford spin forge is a 310 stainless steel combustion chamber exit nozzle. Spinning an explosively shaped preform cuts production time from 18.5 to 3.5 hr per part.

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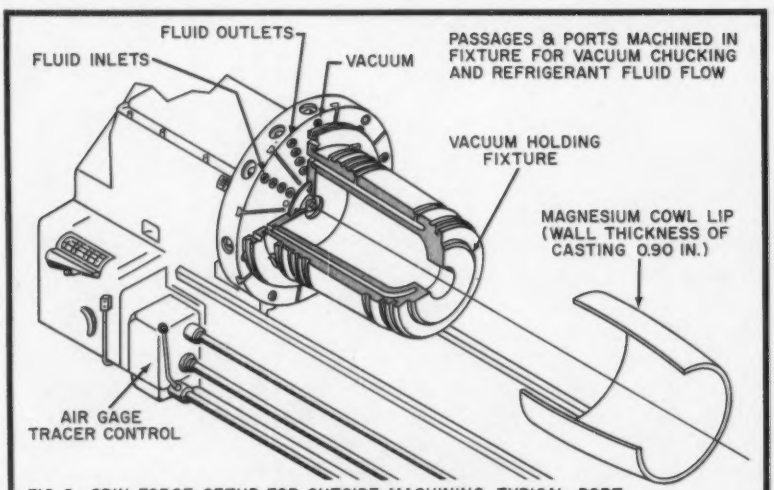
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FLUID INLETS
VACUUM
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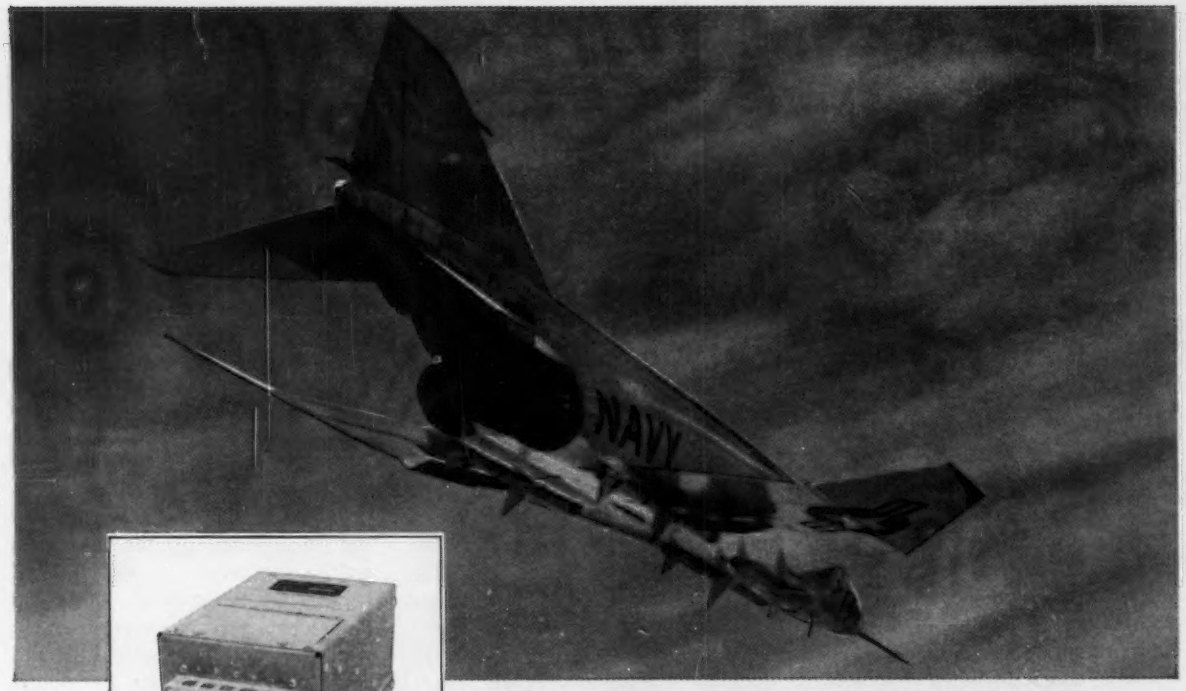
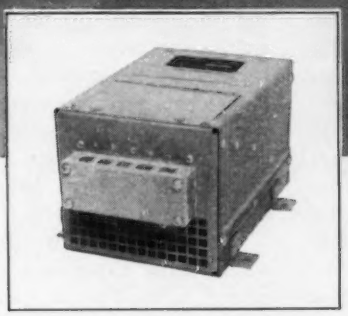
VACUUM HOLDING FIXTURE
MAGNESIUM COWL LIP (WALL THICKNESS OF CASTING 0.90 IN.)
AIR GAGE TRACER CONTROL

FIG. 2 SPIN FORGE SETUP FOR OUTSIDE MACHINING. TYPICAL PORT ARRANGEMENT SHOWS HOW COOLANT ENTERS AND LEAVES THROUGH FACE PLATE.





The McDonnell F4H-1 Phantom II is the newest fighter to take its well-earned place in the U. S. Navy air task-force. The carrier-based or land-based 1500 mph aircraft relies on Chatham transformer-rectifiers to furnish all the d.c. power required by the aircraft. Two Chatham 28VS60 silicon units are operated in parallel.

MCDONNELL F4H-1 uses Chatham transformer-rectifiers

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To realize such full-scale capability, McDonnell could not afford to compromise when it came to specifying equipment for the F4H-1. Emphasizing reliability and dependability, McDonnell selected Chatham to design and manufacture the power conversion equipment. Two Chatham 60 ampere silicon transformer-rectifiers, built to meet the rigorous electrical and environmental specifications of the F4H-1, furnish all the d. c. power required by more than 60 control and navigational circuits and systems.

McDonnell is yet another of the major manufactures of commercial and military aircraft and missiles who depend upon Chatham to deliver the best in airborne power conversion equipment. To maintain the highest performance standards associated with all Chatham equipment, every phase of design and manufacture is carefully controlled by Chatham engineers . . . even to the manufacture of top-quality solid state components. In this manner, Chatham keeps weight and volume requirements to an absolute minimum while delivering power conversion equipment that is unsurpassed for reliability.

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Re-entry By Transpiration

Porous-metal blunt-shaped nose cone performs well in early wind-tunnel tests at MIT; Metalforming process allows model to match theoretical plots

By Lambert H. Mott, President
Mott Metallurgical Corp.

Hypersonic speeds have imposed unheard of specifications on the materials design engineer. The energy carried with the vehicle at these speeds is on the order of 10^3 to 10^4 Btu per pound. The most dramatic manifestation of this energy is in the form of heat in a re-entry body. Within the past few years this has become a problem of international significance.

A number of approaches are being simultaneously investigated toward the solution of the materials problem which exists under the environmental conditions at re-entry. The most straight forward approach is a materials development program. Alloys, cermets and ceramics are being explored which might maintain their structural integrity in the presence of the thermal and mechanical destructive forces.

The heat-sink approach relies upon developing materials with the ability to diffuse the generated heat with sufficient speed to prevent deterioration.

Another approach is to provide a means of dissipation of the generated heat by the ablation of the surface material thus utilizing the latent heats of melting and vaporization as the heat sink.

Transpiration Cooling — The approach which we will deal with here is the control and absorption of the thermal energy transfer by transpiration cooling. This principle involves the injection of a coolant fluid via a porous media into the zone of heat generation. Study has indicated the reduction in heat transfer rate caused by the ensuing thickening of the boundary layer, decrease in thermal gradients and the absorption of the excessive energy by means of the thermal capacity of the coolant. Since the latter characteristic varies inversely with the molecular weight of the coolant for perfect gases, low density coolants such as helium have thus far been advocated.

Porous Blunt Body—Supersonic wind tunnel experience has been gained in the field of transpiration cooling, with a variety of geometric configurations such as porous cones, porous hemispheres, porous strip inserts, partially porous surfaces, etc. The work described in this article was conducted on a 6-in. diam porous hemisphere. The blunt body concept of basically attempting to dissipate a major portion of the energy in the external flow field about the vehicle was combined with the transpiration cooling principle. Aerodynamic and thermodynamic considerations dictated that the porous model exhibit differential permeability in accordance with the curve shown in Fig. 1. Fig. 1 further illustrates the local measured values of flow through the hemisphere supplied by the manufacturer as compared to the specified distribution.

There are a number of ways in which a permeability gradient can be induced in a porous body, including precise control over the density of the material, varying the pore size, or varying the thickness. Weight and bulk were not important factors in the current series of tests.

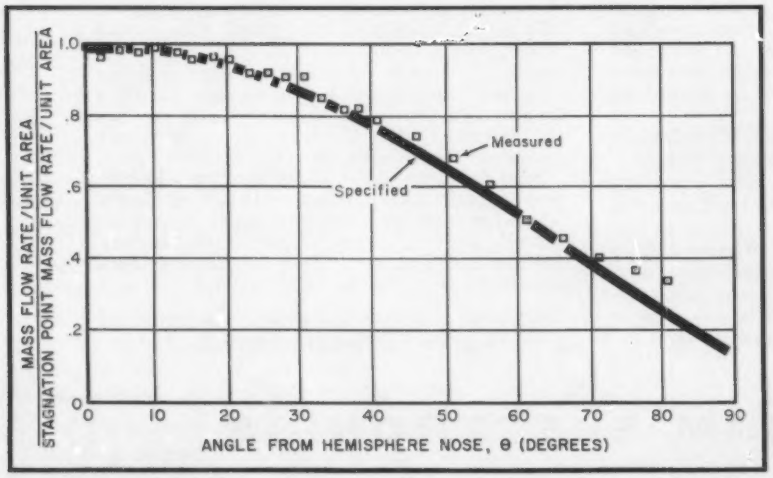

FIG. 1. DIFFERENTIAL PERMEABILITY of transpiration material was to follow design curve. Plots show accuracy of manufacturing process.

The latter method of permeability control (varying thickness) was selected for the fabrication of the model.

Stainless Steel Powder—A basic study was conducted of the variation of flow coefficients with both particle size and thickness of a porous media and the results of this study dictated the employment of a subsieve grade of type 316 stainless steel powder fabricated to a uniform density of approximately 55 per cent.

The geometry of the hemispherical shape required for the model precluded the use of conventional metal powder forming techniques. It was necessary to develop a new forming technique to produce the desired configuration and at the same time avoid any deviation in material density from point to point throughout the structure. The success of the new forming method is illustrated by the data plotted in Fig. 1 which illustrates the agreement between the specified permeability distribution and that actually measured on the hemispherical model.

The model was mounted in a supersonic tunnel and mass transfer evaluations were conducted at test velocities of Mach 3.5 with both air and helium considered as injectants. Fig. 2 illustrates a Schlieren photograph taken of the model during one of the tests. Fig. 3 illustrates the benefits of the injection process as well as an additional possible gain by the judicious choice of a coolant fluid.

These data pertain to a test program specifically oriented towards an evaluation of analyses concerned with uniform surface temperatures and perfect gases. Variations in the porous section arrangement for protection of critical areas is a distinct possibility as is the introduction of coolants with "tailored" effective thermal capacities.

The test work described strongly indicates the advisability of the continuance of mass transfer studies as a means of solving the thermal barrier problem. It indicates the necessity of close liaison between the aerodynamists and the materials manufacturers. The technology of each field of endeavor is advancing rapidly.

A successful marriage of the high temperature porous materials technology with the thermodynamic and aerodynamic technology could conceivably offer a practical solution to one of the greatest problems in the path of space travel.

The writer expresses sincere appreciation to the personnel of the Naval Supersonic Laboratory of Massachusetts Institute of Technology for assistance in the preparation of this article.

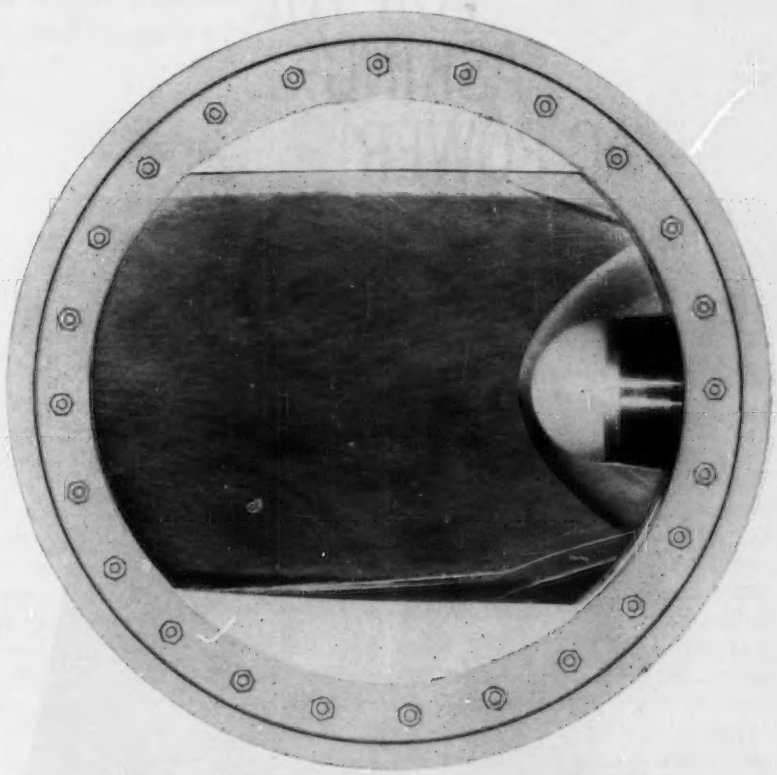

FIG. 2. MASS TRANSFER EVALUATIONS were conducted with porous-metal model at Naval Supersonic Laboratory MIT. Schlieren photograph shows test setup.

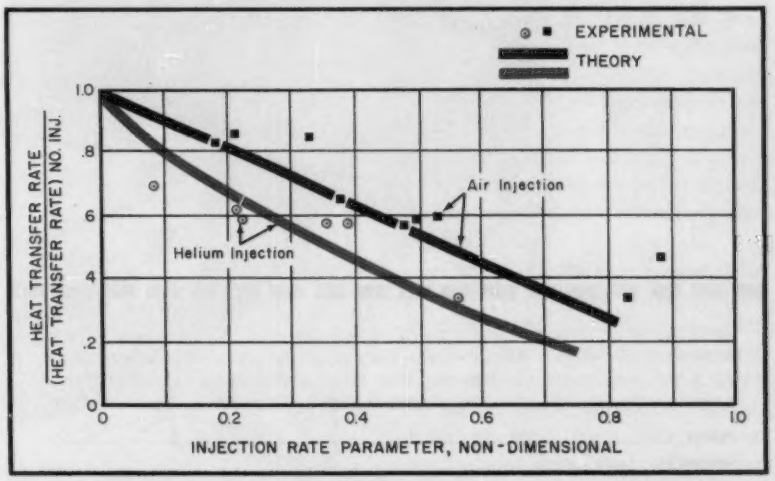

FIG. 3. BENEFITS OF INJECTION cooling are shown in theoretical and achieved plots.

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New Books

. . . *continued from page 9*

WELDING HANDBOOK—SECTION THREE. Edited by Arthur L. Phillips. American Welding Society, 1960. 512 pp., $9.00. The scope of the authoritative Welding Handbook has been widened to include new welding processes and joining methods not previously contained. Chapter coverage includes: Forge, Thermit, and Induction Welding; Surfacing; Metallizing; Brazing; Soldering; Welding of Plastics; Adhesive Bonding of Metals; Oxygen and Arc Cutting; Ultrasonic Welding; Welding by Cold Working; Stud Welding. Some 335 illustrations, 78 tables and a comprehensive index are included.

THE ROBERTSON GUIDE TO WORLD SCREW THREAD STANDARDS. By W. H. A. Robertson & Co., Ltd. 1960. 41 pp., $1.50. The comparison of screw thread standards of the world presents puzzling problems to most engineers. In this handy booklet, over 2000 standards are listed covering the 33 countries which have national standards for screw threads. Illustrations of some 108 screw thread forms are presented, including self-tapping screws.

THE U. S. ATOMIC ENERGY COMMISSION ANNOUNCES — A new feature soon to be incorporated in its series of Quarterly Technical Progress Reviews. In the next issue of Power Reactor Technology (Vol. III, No. 4) to be published soon, a complete subject index will be incorporated. This particular Review will contain a detailed cumulative index to all previous issues, dating back to December 1957. AEC plans to incorporate indexes to two other Technical Progress Reviews (Reactor Fuel Processing and Reactor Core Materials) on a similar schedule as each approached its third anniversary. The fourth Review (Nuclear Safety) will contain an annual index scheduled for publication in June 1961. A three-year cumulative index will follow in June 1962.

Airborne Missile Platform

Donut-shaped Mylar balloon proposed for transport and launch of ICBM's

By Clayton E. Myron,
Design Specialist
Boeing Airplane Co.

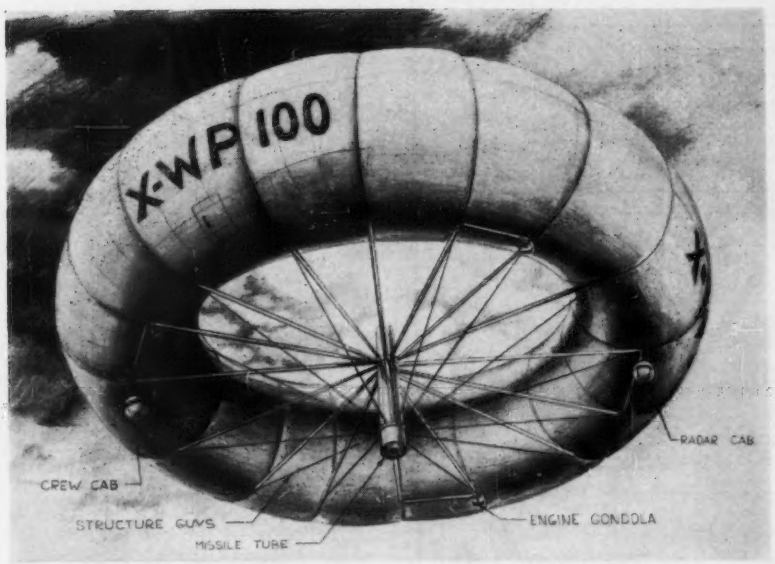
Transporting large missiles is a perplexing problem. It is a military requirement and it faces industry—now. A torus balloon transporter could be the solution. It would have the advantage of substituting as an airborne launching platform.

Design Description — Primary lifting power for the proposed air transporter platform would be supplied by a compartmented Mylar bag. Basic proportions are suggested as 142 ft inside diam and 312 ft outside periphery diam, with a mean cross section of 85 ft. A vehicle of this size would be capable of carrying a Minuteman at an average speed of 65 kts at altitudes up to 20,000 ft. This speed would be obtained with a Mylar covering over both center holes of the torus in order to achieve aerodynamic smoothness. At 10,000 ft altitude, the speed of the platform would be reduced to approximately 30 kts without these coverings.

Beneath the Mylar bag, 16 pressurized aluminum tubes would be suspended in the form of a spoked wheel, terminating in a compression ring encircling the payload capsule. The outermost ends of these tubes would be secured to the main torus by a series of individual cables wrapped around the Mylar bag. The column members would also act as the reservoir for the bag's gas supply when partial deflation is necessary. A single cable about the periphery of the torus would determine their correct alignment.

The column members are seen as 15 in. diam aluminum pipe with a wall gauge of 0.030 in. Pressurized to approximately 100 psi, they would be built with sufficient crown bow so as to deflect back to neutral position when supporting the inflated bag. Since these members would be pressurized, no compression loads would be absorbed and members would react only the imposed load.

Control Capsules—Spaced 180 deg apart beneath the torus are two spherical cabs, 12 ft in diam. The first is a pressurized crew compartment with internal features similar to conventional aircraft. Access would be by a main door, plus a small upper door that will permit the crew to leave the cab during flight for inspection checks of the



TORUS BALLOON transporter, proposed by Boeing would be capable of carrying a Minuteman at about 65 kts at altitudes up to 20,000 ft.

About 3.8 million ft³ of helium would provide lifting force for 100,000 lb payload

platform. A hoist with a 200 ft cable outside the pressurized area, which would make it possible for the crew cab to be lowered to the ground for repairs or a crew change while torus hovers overhead.

The other spherical cab would contain weather and radar surveillance equipment. It would also have room for an operator. Remote cabling and a catwalk would connect the two cabs.

At 120 deg intervals beneath the torus, three radial engines of 3400 hp each mounted on gimbals would provide both thrust and initial lifting power. By mounting these engines so that they revolve in azimuth and swing plus or minus 40 deg in elevation, the need for control surfaces is obviated. Instead, the thrust of the engines, controlled individually, would direct the vehicle along the desired course.

An added advantage of this engine arrangement is the ability to rotate the platform about its center while maintaining a course of flight. In this manner, the heating effect of Sun's rays can be distributed evenly, thereby alleviating concern over uneven gas expansion.

The Missile Capsule—The payload capsule—56 ft in length and seven ft in diam—has been designed to handle loads up to 100,000 lb. An auxiliary hoist, mounted in the upper end of the capsule, permits the payload to be winched into position. The capsule would then be hermetically sealed. Other capsule configurations could be substituted with a slight modification to existing design of cable and column lengths.

The advantages of using the torus as a soft weapon platform include its inherent mobility as compared with existing and proposed methods, the variable altitudes obtainable and the means of maintaining constant instrumentation of the missile. Studies of missile exhausts and the heat resistant qualities of Mylar have established that a missile can be launched from this vehicle without any damage to the bag. If the need arises, the weapon capsule tube could be extended upward to insure adequate flame protection for the inward end of the compression tubes.

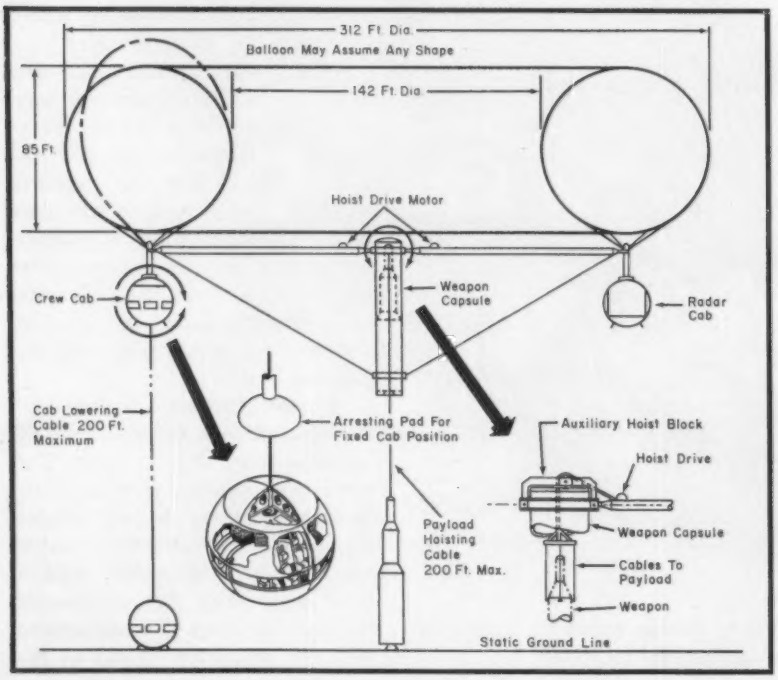
Should it be necessary for the crew to parachute to safety, downward ejection seats would be used. Actual path would be down and outward to assure sufficient side travel to clear the vertical fall of an aborted platform.

Readying for Flight—Preparation of the vehicle for flight would first require an assembly pad capable of restraining a load up to 100,000 lb in order to qualify the platform's maximum lift capabilities. This pad should be equipped with ground anchors and four hold down clamps similar to those used with the Atlas pad release mechanism.

The payload capsule would then be lowered into the assembly pad hole and secured by hold down clamps. The 16 columns would then be bolted to the upper ring on the payload capsule, connection of the 16 suspension cables encircling the bag to their outermost ends would follow. The other end of the suspension cables would be connected to the lower ring of the payload capsule and adjusted by turnbuckles.

The next step is to place the Mylar bag around the outward ends of the columns and put the arresting pads for the crew and radar cabs into position. Intermediate columns between the outward ends of the main column would then be installed to provide pick-up points for the radar and power plants. The 16 restraining cables would then be placed around the main bag and secured to the outward ends of each column.

Inflation of the gas bags would be next. Individual suspension and periphery cables are to be adjusted at this time to level the structural



assembly. Tiedown cables will be used to hold the vehicle erect while the crew and radar cabs and engines are being installed. The main air pumps are then mounted near the outward ends of the main columns, followed by catwalks, ladders, etc.

The auxiliary hoist can be installed with its cable secured to the assembly pad, which will permit the vehicle to rise only as fast as the cable is reeled out. After checking out the engines and equipment, air would be pumped into the lifting bags to provide ballast.

Weapon loading would be accomplished with the platform hovering from 100 to 200 ft above the missile. As the weapon is hoisted upward to the payload carrier, the air ballast that has been pumped into the bags is allowed to escape. Under this loading procedure, the missile will center itself in the carrier.

Cost Factors—While the present design calls for 3.8 million ft^3 of helium to be used in the bag, this could be easily switched to hydrogen for one-third of the cost. As the torus is a free balloon, the absence of a rigid structure reduces the danger of explosion if hydrogen were used.

Based on preliminary design data and assuming that available hardware — engines, ejection seat equipment, mechanical hoist, etc.— would be used, the following costs are estimated for fabrication of one prototype torus balloon platform:

Engineering	$ 2.2 million
Manufacturing	2.5 million
Materials	0.3 million
Tooling	0.2 million
Purchased equipment	1.9 million
Total	$7.1 million

Cost could be reduced to about $3.3 million if the platforms were produced in quantity.

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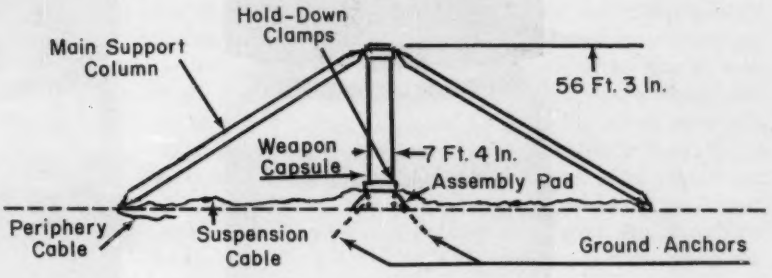
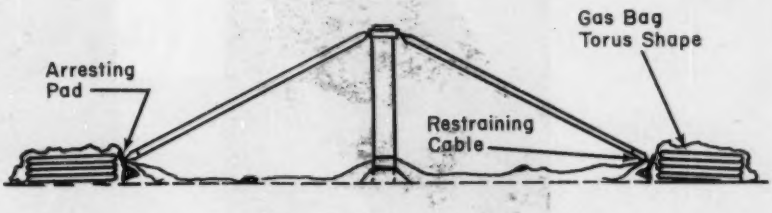
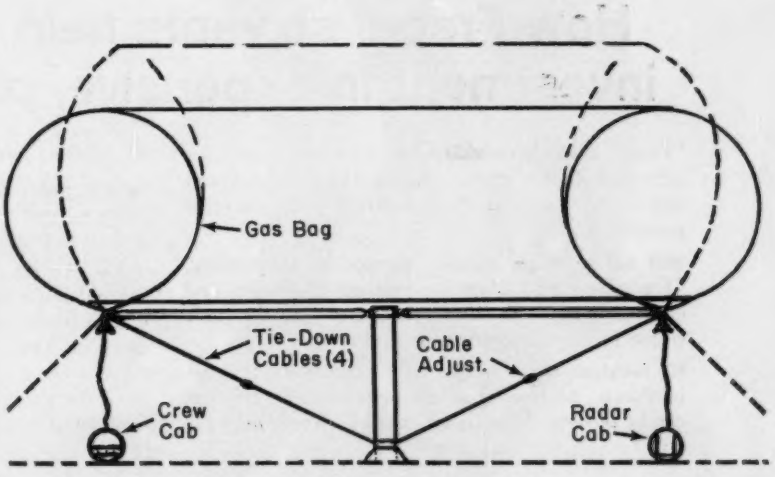
ASSEMBLY AND LOADING



WEAPON CAPSULE is slid inside assembly-pad hole and secured. The 16 main support column tubes are pin jointed to top ring of capsule. The 16 suspension cables are attached to the outward end of the main support columns and the lower ring of the capsule. Periphery cable is attached to outer end of each main support column.



TORUS SHAPED gas bag is placed around outer end of support columns. Restraining cables are attached to the fittings on the end of the support columns as well as at intermediate locations along the periphery cable between the support columns.



BAG IS INFLATED until hold-down clamps meter sufficient lift to take the payload aloft and have enough excess to support 3 powerplants and two cabs, gas bag assumes a free shape.

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Will not damage metals, plastics or elastomers. "Freon" solvents minimize swelling of plastics and elastomers . . . are non-corrosive to metals . . . won't soften paint, wire coating or insulation.

No residue. Because "Freon" solvents contain no inhibitors, no residue is left on dried parts. Solvent can be recovered readily and reused without need for reinhibiting during recovery cycle.

Safe to personnel. Non-flammable and non-explosive, "Freon" solvents are also virtually non-toxic—will not cause headaches or nausea.

For you this means effective, remarkably safe cleaning of delicate mechanical and electronic equipment—greater protection for your investment. If you'd like more information about "Freon" solvents or technical assistance on solvent use and application, write: E. I. du Pont de Nemours & Co. (Inc.), "Freon" Products Division, Wilmington 98, Delaware.

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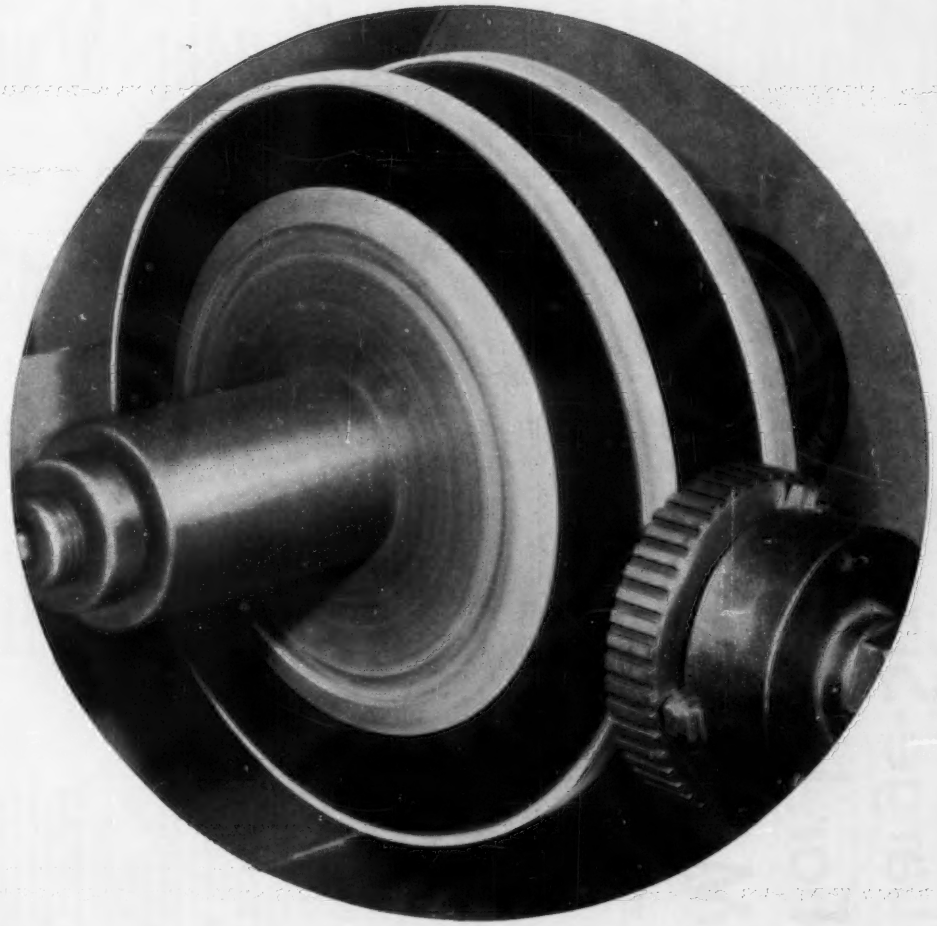


Where To Find Large-Size Furnaces For Heat Treating Metal Assemblies

The surging technology of the aerospace age has placed unprecedented demands on materials of construction. To obtain high strengths and meet tight tolerances, great emphasis has been placed on heat treatment, especially for high strength steels.

Surface reactions that occur during heat treatment are usually prevented, or at least minimized, by filling the heating chamber with a protective atmosphere or by heating in a neutral molten salt. The most familiar types of protective atmospheres are exothermic, endothermic, nitrogen, inert gases, dry hydrogen, and vacuum. No one atmosphere is suitable for all heat treatments. The most common protective atmospheres, endothermic and exothermic, are obtained from the products of combustion of hydrocarbon fuel gases.

Where can aerospace contractors find the facilities that are necessary in getting the demanding heat treating tasks accomplished? The Defense Metals Information Center has surveyed a large number of the heat treaters across the country. Their capabilities and their equipment are summarized in the following table.

✦

A REPRINT

of this article can be obtained by writing on company letterhead to The Editor, AIRCRAFT & MISSILES, Chestnut & 56th Sts., Phila. 39, Pa.

Company	Description of Furnace				Types of Protective Atmospheres	Maximum Temperature	Quenching Media	Tempering Facilities	
	Type of Furnace	Method of Heating	Size of Heating Chamber: Furnace Opening, inches	Size of Heating Chamber: Length, feet				Size—Diam., inches; Length, ft.	Maximum Temperature
Western Section									
Aerojet-General Corp., Azusa, California	Bottom-open, Gantry	Electric	100 diam	21	Endothermic	2050° F		100″ diam x 21′	1450° F
Sacramento, California	Bottom-open, Gantry	Electric	96 diam	20	Endothermic		Salt, oil	—	—
North American Aviation, Los Angeles, California	Bottom-open, Gantry	Electric	84 diam	29	Endothermic, argon, nitrogen	2050° F	Nitrogen, water	84″ diam x 24′	1250° F
Menasco Manufacturing Co., Fort Worth, Texas	Bottom-open, Gantry	—	80 diam	24	Endothermic	2050° F	Salt, water	80″ diam x 24′	1250° F
Lindberg Steel Treating Co., Los Angeles, California	Bottom-open, Gantry	Electric	80 diam	16	—	—	—	—	—
The Marquardt Corp., Ogden, Utah	Bottom-opening	Electric	80 diam	10	Endothermic and exothermic	2000° F	—	80″ diam x 10′	1000° F
Marquardt Aircraft Co., Van Nuys, California	Bottom-open, Gantry	Electric	72 diam	10	Endothermic	2000° F	—	72″ diam x 10′	1000° F
Norris-Thermador, Los Angeles, California	Bottom-open, Gantry	Gas	60 diam	11	Endothermic	1800° F	—	60″ diam x 16′	1300° F
	Bottom-open, Gantry	Gas	96 diam	20	Endothermic	—	Salt	—	—
Douglas Aircraft Company, Inc., Torrance, California	Bottom-open, Gantry	Electric	74 diam	18	Endothermic and exothermic	2000° F	—	74″ diam x 18′	1300° F
	Bottom-opening	Electric	48 diam	10	Exothermic	1800° F	Oil	—	1250° F
Menasco Manufacturing Co., Burbank, California	Vertical	Electric	72 diam	13	Endothermic	2000° F	Water, oil, salt	72″ diam x 13′	—
California-Doran Heat Treating Co., Los Angeles, California	Bottom-open, Gantry	Radiant tube-gas	60 diam	16	Exothermic, nitrogen Endothermic, or argon	1900° F	—	60″ diam x 16′	1150° F
	Top-open pit	Gas	60 diam	6	Endothermic and exothermic	1900° F	—	42″ diam x 16′	1700° F

Boeing Airplane Company, Seattle, Washington	Gantry	Electric	60 diam	14	Endothermic	2050° F	—	60″ diam x 14′	1450° F
Lockheed Aircraft Corp., Burbank, California	Bottom-open, Gantry	Electric	60 diam	15	Endothermic	2050° F	—	60″ diam x 15′	1450° F
E and J Heat Treating, Inc.	Bottom-open, Gantry Top-open pit	Radiant tube-gas Electric	84 diam 48 diam	10 16	Endothermic Endothermic	1950° F 1900° F	Oil, water Oil, water	48″ x 16′ 72″ x 20′	1250° F Quench pits for both furnaces
Solar Aircraft Company, San Diego, California	Top-open pit	Electric	108 diam	30	Endothermic, nitrogen, hydrogen, argon	1950° F	Air	108″ diam x 30′	1950° F
North American Aviation, Downey, California	Horizontal	—	78 diam	40	Vacuum or inert gas	2250° F	Cooled inside furnace by inert atmosphere	—	—

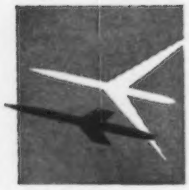
(a) Vertical unless noted. (b) Two salt pots of this size.

Central Section

General Electric, Rocket Engine Section, Cincinnati, Ohio	Bottom-open, Gantry	Electric	120 diam.	30	Endothermic	2000° F	Salt, water, air, oil (available)	120″ dia x 30′ (two	1400° F
Army Ballistic Missile Agency, Redstone Arsenal, Alabama	Bottom-opening	Electric	96 diam.	10	None (air)	1200° F	—	96″ dia x 10′	1200° F
Lindberg Steel Treating Co., Melrose Park, Illinois	Bottom-open, Gantry	Electric	80 diam	24	Endothermic, nitrogen, argon	2050° F	Salt, nitrogen (gas), water	80″ dia x 24′	1250° F
Thompson-Ramo-Wooldridge, Inc., Cleveland, Ohio	Bottom-open, Gantry	Electric	72 diam	22	High nitrogen, argon, endothermic	2050° F	Salt, oil, water	72″ dia x 22′	1400° F
Commercial Steel Treating Corp., Detroit, Michigan	Bottom-open, Gantry Bottom-open, Gantry	Radiant tube-gas Radiant tube-gas	70 diam 70 diam	28 14	Endothermic Endothermic	1850° F 1850° F	Oil Oil	70″ dia x 22′ —	1250° F —
Goodyear Aircraft Corp., Akron, Ohio	Bottom-open, Gantry	Electric	68 diam	21	Nitrogen	1950° F	Salt, water	72″ dia x 22′ (two)	1400° F
Metallurgical, Inc., Minneapolis, Minnesota	Bottom-open	Electric	66 diam	22	Any atmosphere required	2200° F	Salt	84″ dia x 24′	1250° F
Wall Colmonoy Corp., Detroit, Michigan	Vertical	—	72 diam	10	Dry hydrogen, argon, nitrogen, carbon dioxide, exothermic	—	—	—	—
Ingersoll Kalamazoo Division, Borg-Warner Corp., Kalamazoo, Mich.	Bottom-drop	Electric	42 diam	13	Endothermic	1800° F	Oil	72″ dia x 14′	1400° F
A. O. Smith, Milwaukee, Wisconsin	Top-open pit Top-open pit	Electric Electric	60 diam 54 diam	10 12	Inert or recarb. Inert or recarb.	1750° F 1750° F	— —	54″ dia x 12′ (two) —	1350° F —
The National Acme Co., Cleveland, Ohio	Top-open pit Top-open pit	Electric Electric	30 diam 30 diam	7.6 6.6	Endothermic Endothermic	1900° F 1900° F	— —	30″ dia x 7′ 8″ 30″ dia x 6′ 8″	800° F 800° F
Griscom-Russell Company Massillon, Ohio	Top-open pit	Gas	26 diam	22	Exothermic, nitrogen, helium, hydrogen	2100 °F	—	26″ dia x 22′	Furnace or air cooling
Allison Division, General Motors Corp., Indianapolis, Indiana	Bottom-open	—	—	—	—	—	—	—	—

Eastern Section

J. W. Rex Company, Lansdale, Pennsylvania						—	—	71″ x 22′ (2)	1500° F
	Bottom-open, Gantry	Electric	71 diam	22	Endothermic	1950° F	Salt	71″ x 15′	1500° F
						—	—	71″ x 8′	1500° F
	Bottom-open, Gantry	Electric	60 diam	15	Endothermic	1950° F	Oil	60″ x 13′	1500° F
	Bottom-open, vertical	—	144 diam	22	Endothermic	—	—	—	—
						—	—	60″ x 57″ x 12′ 6″	850° F
H. K. Porter Company, Inc., Ambridge, Pennsylvania	Bottom-open, Gantry	Gas	48 diam	13	Endothermic	1700° F	—	36″ x 13′	1700° F
	Bottom-open, Gantry	Gas	36 diam	18	Endothermic	1700° F	—	48″ x 18′	1700° F
Alco Products Manufacturing Company, Dunkirk, New York	Bottom-opening	Electric	44 diam	13.6	Endothermic	1950° F	Oil or water	72″ x 48″ x 20′ (horiz.)	1350° F
						—	—	44″ x 13′ 8″ (vert.)	1250° F
Pittsburgh Commercial Heat Treating Co., Pittsburgh, Pennsylvania	Bottom-opening	Electric	44 diam	10	Endothermic	1900° F	—	40″ x 10′	1850° F
Metlab Company, Philadelphia, Pennsylvania	Bottom-opening	Propane gas	36 diam	14	Endothermic or exothermic	1850° F	—	Available according to requirements	—
Parish Pressed Steel, Reading, Pennsylvania	Top-open pit	—	30 diam	12′–11″	Products of combustion	1650° F	—	36″ x 68″ x 23′ 4″ (horiz.)	1300° F
S. D. Hicks, Asheville, North Carolina	Salt pot	Gas	72 sq	20	Neutral salt	—	Oil	—	—
The Hicks Corporation, Boston, Massachusetts	Salt pot	Electric and gas	48 sq	15	Neutral salt	—	—	—	—
	Salt pot	Electric and gas	33 diam	16	Neutral salt	1700° F	—	72″ sq x 20′ (horiz.)	1300° F
M. W. Kellogg Company, Jersey City, N. J.	Salt pot	—	48 sq	15	Neutral salt	—	—	—	—
	Salt pot	Electric	30 diam	10	Neutral salt	1700° F	—	36″ sq x 12′	1300° F
	Salt pot	Electric	30 diam	10	Neutral salt	1300° F	—	36″ sq x 6′	1300° F
Pratt-Whitney, East Hartford, Connecticut	Gantry-type	Electric	90 diam	12-16	Endothermic and nitrogen	2000° F	—	—	—



Men on the Move

R. M. Hatcher
Convair-San Diego

R. M. HATCHER, named manager of applied manufacturing research and process development at Convair-San Diego. CHARLES S. AMES, JR., named program director-Atlas at Convair-Astronautics.

GEORGE L. DOWNS, named manager of the Minuteman program office at the Amherst Laboratories of Sylvania Electric Products Inc.

Charles S. Ames, Jr.
Convair-Astronautics

BRUCE A. WORCESTER, named director of product support; HAROLD F. ERDLEY, director of the Guidance Systems Laboratory; DR. NORMAN ENENSTEIN, director of the Tactical Systems Laboratory, and DR. THOMAS P. CHEATHAM, JR., director of the Advanced Development Laboratory at Litton Systems.

JOHN F. COONEY appointed manager of Central Services at Ford Motor Company's Aeronutronic Div. ROBERT B. KATKOV, named manager of Tactical Missile Systems in Weapon Systems Operations.

Dr. Vincent R. Learned
Sperry

DR. VINCENT R. LEARNED, named manager of the Electronic Tube Div., Sperry Gyroscope Co.

W. L. WHITTIER, named works manager and HOWARD W. CLEVELAND, manufacturing control manager, at Douglas Aircraft's Long Beach Div.

James M. Hait
FMC

HARRY A. PEARL, appointed supervising engineer of the materials laboratory at Republic Aviation Corporation's new Research and Development Center.

JAMES M. HAIT, elected president of Food Machinery and Chemical Corporation.

ELMER F. HINNER and JOHN M. MARTIN, elected vice presidents of Hercules Powder Co.

JAMES R. WEINER, appointed vice president-engineering for Philco Corporation's Government and Industrial Group.

Irwin Klugler
Lockheed Electronics

IRWIN KLUGLER has joined Computer Systems, Information Technology Div. of Lockheed Electronics Co., as a senior mathematician.

DR. DONALD G. WILSON, named vice president-research of P. R. Mallory & Co.

ROBERT G. NUNN, JR., appointed special assistant to NASA Administrator T. Keith Glennan.

WALTER T. BONNEY, appointed director of public information of Aerospace Corp. Mr. Bonney had been director of NASA's Office of Public Information.

STUART E. WEAVER and HARRY B. HORNE, elected vice presidents of The Marquardt Corp.

MILTON F. PRAVDA has joined The Martin Company's Nuclear Div. as chief of system design.

GIFFORD K. JOHNSON, named executive vice president of Chance Vought Aircraft.

MICHAEL HACSKAYLO, appointed director of research for Semi-Elements Inc.

P. W. PERDRIAU, named president of the Industrial Products Co., B. F. Goodrich Aviation Products.

JAMES H. BROWN, named vice president for administration at Grand Central Rocket Co.

L. W. WARZECHA, named project manager of the General Electric Missile and Space Vehicle Dept. feasibility study group for Project Apollo. E. J. MERRICK, named project engineer of the group. J. PIETER DE VRIES, appointed manager of astrodynamics for the MSVD Space Sciences Lab.

GEORGE KAPPELT, appointed director of engineering laboratories for Bell Aerosystems Co. DR. SAUL BARRON, named head of a new Research Dept. conducting studies in major aerospace problem areas.

DONALD A. FORBES, appointed to fill the new position of chief development engineer in the Ceramic Dept. of the Electrical Products Div., Corning Glass Works.

Dr. Donald G. Wilson
Mallory

Milton F. Pravda
Martin

Michael Hacskaylo
Semi-Elements, Inc.

George Kappelt
Bell Aerosystems

Dr. Saul Barron
Bell Aerosystems

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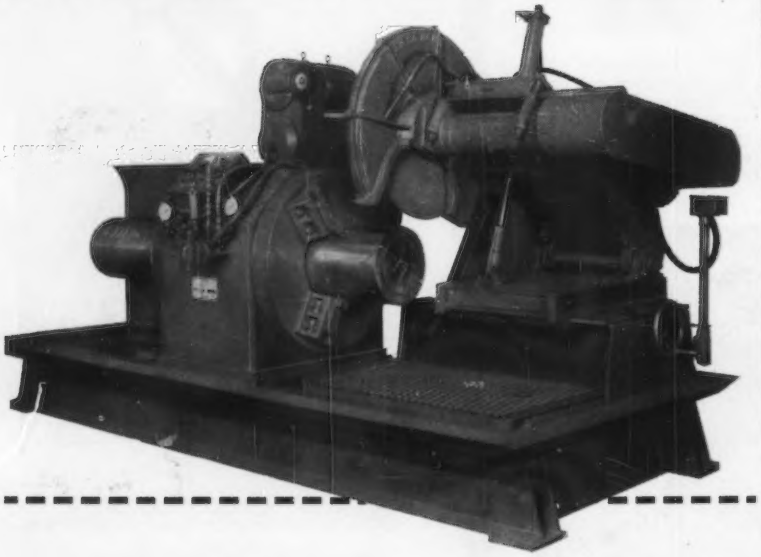
NEW Abrasive Saw Rotates Metal . . . Cuts 16 to 20 IPM's on Hard Alloys



If you produce large rounds or squares, the new Rotator will reduce your cutting time to a minimum . . . 16 to 20 square inches per minute on hard alloys. It's the only rotator-type saw with a chuck that will hold rough forgings and rounds, as well as conventional rounds up to 14" diameter. Material is rotated as it is cut, keeping a cooler surface at the point of blade contact . . . result — longer blade life. Self-contained and portable, with integral tank and re-circulation pump.

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High-temperature alloys

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Engineering details of nine wide-range transistorized power supplies; and five high current DC power supplies.—*Armour.*

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Thread Rolling

Booklet illustrates and describes various thread rolling applications using the LANHYROL thread rolling machine.—*Landis Machine Co.*

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Torque Wrenches

Complete presentation of how to understand and use torque wrenches. Third edition offered free to potential torque wrench users only.—*P. A. Sturtevant Co.*

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Eight-page illustrated summary of the Air Force satellite recovery vehicle program covering Discoverers I through XIV.—*General Electric Co., MSVD.*

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Aeronutronic

Four color brochure, "This Is Aeronutronic," shows management, programs, progress of Space Age firm. —*Aeronutronic Div., Ford Motor Co.*

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Full color brochure shows and describes the pressurized Tempo II business aircraft.—*L. B. Smith Aircraft Corp.*

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Energy Absorber

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Silicones

Physical properties of firm's silicones with illustrated examples of their use.—*Dow Corning Corp.*

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Bulletin provides detailed information on improved cutting techniques for industrial "Airbrasive" units.—*S. S. White, Industrial Div.*

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Urethane Foams

Brochure is a dual-purpose pictorial progress report and designer's fact file on industrial and commercial applications for urethane foams.—*Mobay Chemical Co.*

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Missile Components

Folder illustrates firm's guidance system components and describes facilities and equipment.—*General Machine & Instrument Co.*

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Numerical Control

Brochure on Singer numerical control system.—*Diehl Mfg. Co.*

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Mounting Tubing

Engineering design manual (Bulletin 212G) offers a compiled listing of materials and specifications, recommended application and the latest technique for mounting tubing, wiring and similar hardware.—*Ta Mfg. Co.*

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Avcomb

Structural properties of Avcomb sandwich construction. — *Nashville Div., Avco Corp.*

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Spherical Bearings

Six-pg. bulletin on rod ends and sherical bearings lined with Teflon.—*The Heim Company.*

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Power Supplies

Illustrated brochure describes complete line of solid state power supplies and power conversion devices. *Power Sources, Inc.*

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Resistance Cards

Bulletin on metal film resistance card, highly stable microwave attenuator material.—*Filmohm Corp.*

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Facts & Figures

Booklet has data on the Southern market and on Atlanta.—*Industrial Bureau, Atlanta Chamber of Commerce.*

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Doppler Facts

Fact file on GPL's commercial Doppler system.—*GPL Div., General Precision.*

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Self-teaching manual makes it possible for engineers and scientists to master the Bendix G-15 ALGO compiler.—*Bendix Computer Div.*

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27-page detailed reprint "Steels for the Containment of Liquefied Gas Cargoes."—*U. S. Steel Corp.*

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Emergency Escape

Paper presented at International Astronautical Congress contains diagrams and complete descriptions of proposal to use foam-in-place urethanes for emergency escape capsules in manned satellites. — *MSVD, General Electric Co.*

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Facsimile Recorder

Brochure describes recorder for weather maps, charts — *Westrex Corp., Div. of Litton Industries.*

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Pioneer

Booklet illustrates Pioneer rocket engine with added design facts—*Reaction Motors Div., Thiokol Chemical Corp.*

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Diffusion Coating

Pamphlet on firing diffusion coattings—*Haynes Stellite Co.*

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Monitor

Brochure on high-speed temperature monitor system — *Monitor Systems Inc.*

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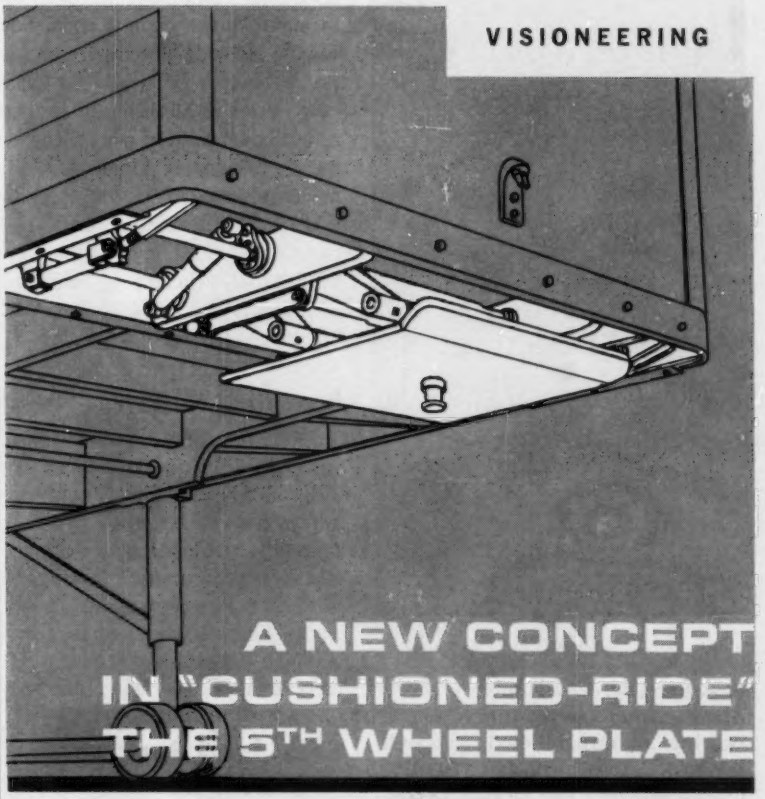

■ Unlike our other heavy-duty, soft-ride suspension systems, the 5th Wheel Plate utilizes torsion bars instead of springs. This unit was designed and patented primarily for trailers hauled by tractors and provides the maximum shock resistance for the most fragile of cargoes, regardless of road or terrain.

At present our patented 5th Wheel Plates are in military service in various ground support operations, but there are many practical commercial applications.

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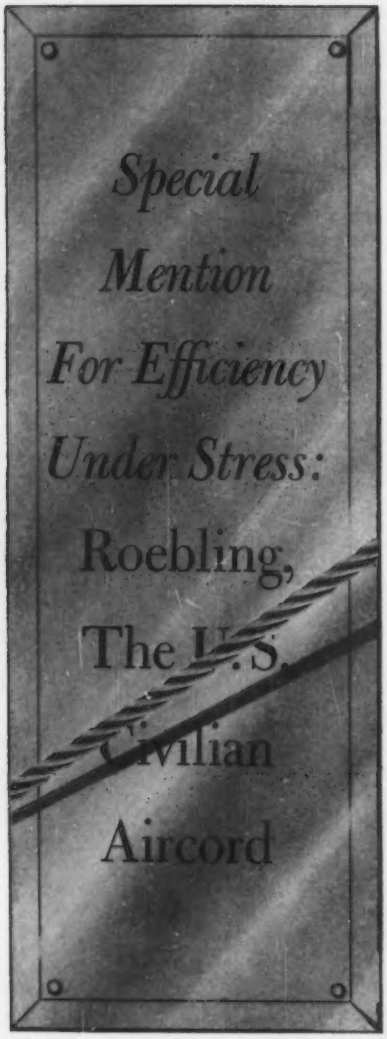

Roebling Aircord—tinned or galvanized carbon steel—comes to you bearing an unparalleled "research pedigree." It is built and tested to exceed *military* specifications: constructional stretch has been virtually eliminated. Roebling makes Lock-Clad Aircord (aircraft cable with aluminum tubing swaged around it), stainless steel aircord, assemblies with fittings swaged to cable ends, as well as a complete line of slings.

Plane manufacturers and air supply houses interested in the qualities of Roebling aircord assemblies or slings, may address inquiries to Wire Rope, John A. Roebling's Sons Division, Trenton 2, N. J.

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Circle 21 on Inquiry Card

New Materials

Ceramic In Metal

Unique metallurgical process combines ceramic fibers with metal to attain high strength. The basic concept of the method is similar to that in which a combination of glass fiber and plastic has been used to make "glass" fishing rods. Some of the new high-temperature ceramic fibers now available for incorporation in metals have strengths as high as 3 million psi. Strength of the metal matrix alone would, in no case, exceed one-half million psi. Substantial reinforcement of the metal structure is possible even though the structure is being used at temperatures close to the melting point.—Horizons Inc.

Circle 90 on postcard for more data

Marking Teflon

High-potency compound reacts with the Teflon surface to create a dark carbon film that is completely impervious to the temperatures normally encountered in Teflon service. It is good for marking part number and other data on TFE parts. Agent is supplied in a polyethylene squeeze bottle with a long, tapered nozzle.—Plastic Assoc.

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TFE-Lined Bearings

Rod end bearings lined with a woven fabric of "Teflon" TFE-fluorocarbon fiber give good performance on helicopter tail rotors.

Metal-to-metal bearings on a Hiller 12E helicopter had a life of from 75 to 100 hr. They received daily lubrication. Bearings lined with "Teflon" TFE fiber were in good condition following 450 hr of service without lubrication. Furthermore, Hiller engineers found these fiber-lined bearings more efficient and sturdy than metal-to-metal rod end bearings.—E. I. du Pont.

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Teflon Spheres

Solid Teflon spheres are used as spacer or filler material to maintain a specified volume of liquid in a container. Spheres are available in a wide range of diameters. Most liquids deteriorate or evaporate over a period of time. The use of spacer spheres permits effective operations with smaller amounts of fluids. A typical application of the units to control volume is in oil filled circuit breakers and transformers.—Garlock Inc.

Circle 93 on postcard for more data

Flexible Laminates

Flexible, thin, reinforced plastic laminates are available with embedded electric heater elements. The new laminates can be designed for various watt densities with maximum surface temperatures in the 400° to 500°F. Sheets only 0.021 in. thick resist electrical breakdown in saline solution immersion tests under 250 volts.

The thinner laminates are flexible, easily wrapped around a 4-in. diam mandrel without damage. Sheets are available in sizes up to 36 x 48 in.—Bischoff Chemical Corp.

Circle 94 on postcard for more data

Irradiated Tubing

Polyolefin tubing and sleeving material heat-shrinks to form a tight bond, even over irregular shapes. It is called Hyshrink and is flame retardant and thermally stable. Heating does not affect the flexibility of the irradiated tubing. Longitudinal shrinkage is less than 10 per cent. It is an excellent insulating material with high dielectric and mechanical strength. It has good resistance to radiation damage.—Sequoia Wire & Cable Co.

Circle 95 on postcard for more data

continued on page 60

Circle 40 on Inquiry Card ⟶

Failure of any part of a missile—be it the mighty Atlas, Jupiter or Thor—can mean failure of the mission. That's why the complex connections in the ducting systems of these and other missiles are silver brazed. These connections must stand up under 6,000 psi; they are tested to 12,000 psi.

In lines made to specifications by Flexonics Corporation, Maywood, Illinois, silver brazing joins a corrugated flexible pressure carrier, a braid sleeve and a coupling nipple—all of stainless steel; it permits joining all of these elements of the assembly without danger of annealing the pressure-carrying flex or the restraining braid as welding might do.

Assemblies designed for 6,000 psi operating pressure are required to withstand a 12,000 psi test and take four times their normal operating pressure before failure. They may also be required to pass a flame test in order to meet specifications.

The silver-brazed connections are used on hydraulic and pneumatic systems, fuel drain lines and vent tubes. Some of these applications involve rigorous service with extreme pressure shocks accompanied by sudden elevations of temperature, which may go from −60° to 400-600° F in a matter of seconds.

A more "high level" endorsement of Handy & Harman silver alloy brazing is not available. On the ground or in the air, the qualities of this remarkable metal joining method apply; strength, ease of production, cost, gas and liquid joint tightness to name a few. The entire brazing story is yours merely for the asking. Inquiries and metals-joining "problem exposure" may be addressed to Handy & Harman, 82 Fulton Street, New York 38, N. Y. We welcome the opportunity to work with you.

Your NO. 1 Source of Supply and Authority on Brazing Alloys

HANDY & HARMAN

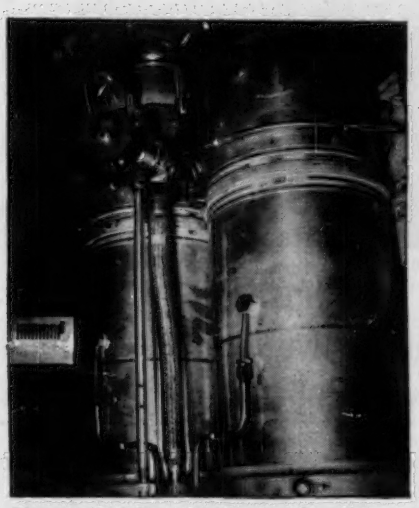
General Offices: 82 Fulton St., New York 38, N. Y.

DISTRIBUTORS IN PRINCIPAL CITIES

No Margin Here for joint failure!

Assemblies in ATLAS Missile **HANDY & HARMAN** Silver Brazed

Intercontinental Atlas missile being made ready for launching.



Close-ups of missile section, showing silver alloy brazed ducting assembly.

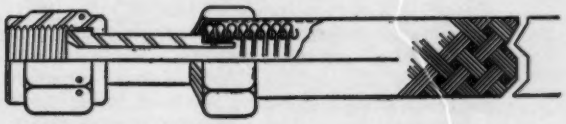


Diagram of pressure carrier.

FOR A GOOD START: BULLETIN 20.

This informative booklet gives a good picture of silver brazing and its benefits...includes details on alloys, heating methods, joint design and production techniques. Write for your copy.

Another "impossible" job done by the Airbrasive...

abrading • cutting • deburring • stripping • drilling • cleaning • scribing

Eclipse-Pioneer found: Airbrasive reduces lapping time from eight hours to 15 minutes!

When Eclipse-Pioneer, Division of The Bendix Corporation, hand-lapped shallow inclines in these alloy steel thrust bearings to depths of 0.0002" to 0.0004", it took *eight hours* of laborious effort.

The S. S. White Industrial Airbrasive "does a better job... *and takes 15 minutes!*" they tell us.

Here is a unique industrial tool of many uses... cutting semiconductors... adjusting microelectronic circuits... removing microscopic burrs... cleaning surfaces... and many others. It performs its magic with a superfine stream of abrasive particles and propellant gas that quickly cuts almost any hard, brittle material.

Important too... The Airbrasive is available at a cost you can afford... Under $1,000.00!

Send us samples of your "impossible" jobs and we will test them for you at no cost.

SEND FOR BULLETIN 6006
... complete information.

S. S. White

S. S. White Industrial Division
Dept. 18A, 10 East 40th Street, New York 16, N. Y.

New Materials

... continued

Titanium For Jet Engines

A new creep-resistant alloy extends titanium's useable strengths in jet engines to 900°F. The metal has been used for unstressed airframe parts at temperatures nearing 1000°F. Designated Ti-8Al-1Mo-1V, the alloy contains eight per cent aluminum and one per cent each of molybdenum and vanadium. The balance is titanium.

Because of a relatively high aluminum content, its density is low (0.156 lb/in.^{3}). Tensile properties are comparable to the heat-treatable titanium alloy grade Ti-6A1-4V.—Titanium Metals Corp. of America.

Circle 96 on postcard for more data

Solid Propellant

Hydrazine diborane is a promising compound for missile and rocket propulsion. Experimental and developmental quantities of the compound are available for immediate delivery. Hydrogen content of the compound, together with its chemical and thermal properties, enhance its suitability for propellant chemistry. The compound is a white, crystalline, free-flowing powder with a molecular weight of 59.7. Density is reported as 0.91 grams/cc, and heat of formation at minimum 30 Kcal/mole.—Callery Chemical Co.

Circle 97 on postcard for more data

Glass For Bionics

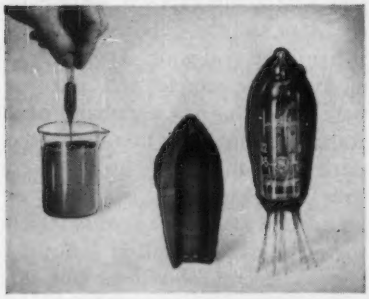
New kind of glass helps detect and identify extremely tiny amounts of radiation. Radioactivity of the glass is less than six per cent of comparable glasses. Low radioactivity is a necessity in electronic equipment precise enough for such small measurements. Immediate use will be in bionics for fast and accurate measurement of beta and gamma radiation in human beings. —Corning Glass Works.

Circle 98 on postcard for more data

General Electric Silicone Rubber finds dozens of uses in missile systems. How many more will prove vital?

General Electric silicone rubber has the "thermal toughness" to stand up under the searing heat of rocket blast-off or possible atomic attack. Add very good electrical properties and excellent resistance to aging, weathering, moisture, flame, ozone and corona and you can easily see why silicone rubber is now being used in virtually every U.S. missile and space vehicle.

Since both space technology and silicone rubber are relatively new, General Electric believes there are many more areas not yet explored where silicone rubbers can help keep a missile functionally reliable and combat-ready. To help designers in their evaluation work, we list here the principal properties and applications of G-E silicone rubber.



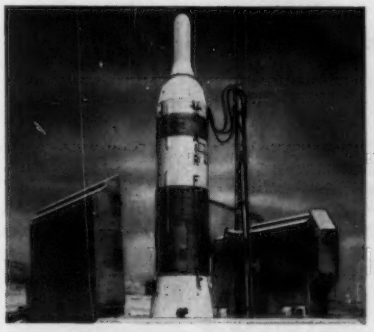
RTV LIQUID SILICONE RUBBER — One of the most versatile materials developed in recent years, RTV is a liquid rubber that cures at room temperatures. Like all silicone rubber, it remains flexible over a wide temperature range and is virtually ageless. Since it comes in a wide range of viscosities, it can be poured, sprayed, dipped, painted or applied with a pressure gun or spatula. It bonds tightly to metal when a primer is used. When not primed, you can readily remove RTV and then reapply more. You can impregnate tightly wound coils with RTV or form sections several inches thick.

You can control cure time from two minutes to 24 hours. These are RTV's typical properties:

Viscosity	from 120 poises (very pourable) to 12,000 poises (paste)
Specific Gravity	1.2 to 1.5
Solids Content	100%
Shrinkage	0.2%
Heat Resistance	from —90°F to 600°F, and as thermal insulation, in 5500°F flame for minutes
Ozone Resistance	Comparable to Mica
Electrical Properties	See last table

Applications—RTV is used as a high temperature structural sealant in missiles, satellites and space vehicles. It is used to pot and encapsulate electronic components and assemblies for electrical and heat insulation and for protecting delicate components from physical damage. It is commonly used as an impregnating insulation in transformer coils, to pot and hold cable in raceways and to pot cable breakouts. You can make flexible molds with RTV and hence make accurate, duplicate castings from originals.

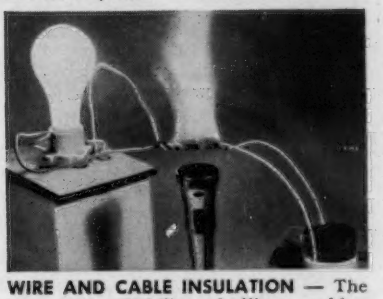
RTV is an excellent thermal barrier and as such is applied on and around missile nozzles. Tests show RTV's resistance to flame temperatures as high as 5500°F for several minutes. RTV also functions as a flexible ablative material and is used around probe holes, along raceways, and between stages and structural joints on the missile skin.



HEAT CURED SILICONE RUBBER PARTS —Silicone rubber gaskets, port seals, O-rings, shock mounts and other mechanical parts are not only used on missiles but have wide application in ground support equipment. For instance, missile silo doors use silicone rubber seals that will stand up to outside weathering, ozone and abuse for years and which will also resist the heat of missile launching and nuclear attack. Silicone rubber also resists brief exposure to cryogenic materials.

Silicone rubber has long-lasting temperature resistance from —150°F to 600°F, with excellent electrical, weathering, ozone, corona, radiation and nonaging properties at these temperatures. High tensile strength and low compression set are also within its range of desirable properties:

Tensile Strength, psi	800—1500
Elongation, %	100—600
Hardness Durometer (Shore A)	25—80
Compression Set, %	10—80
Tear Resistance lb/in	40—200
Radiation Resistance	1×10^8 roentgens
Electrical Properties	See table below



WIRE AND CABLE INSULATION — The long term reliability of silicone rubber when operating in high ambient temperatures and when current over-loads cause the conductor to approach 500°F is an important feature of silicone insulation. In an 1800°F flame, specially constructed silicone rubber insulated cables will continue to insulate for hours, forming a non-conductive ash that gives off no toxic fumes. And short term reliability is obtained even when silicone rubber is exposed momentarily to a direct flame of 5500°F.

Because of this excellent heat resistance, more current can be carried than in conventional cable (or smaller cable can be used). Other features: best compression set of all elastomers at temperature extremes, so that silicone rubber wire and cable does not deform under clamps; high ozone, corona, radiation and weather resistance, low moisture absorption, flexibility down to —100°C. These are the typical properties:

Volume Resistivity	10^{15}—10^{16}
Dielectric Strength, volts/mil	600—650
Dielectric Constant, 60 cps	3.0
Power Factor	.0010—.0050
Radiation Resistance	1×10^8 roentgens
Physical properties	Similar to table above.

Applications—Wiring harness made of silicone rubber insulation is often found throughout missiles. Cable offers added reliability for use in various places throughout the launch complex below ground from power plant to silos. All combat vessels built for the U.S. Navy during the last ten years, including fleet ballistic missile submarines and the new nuclear-powered cruiser and aircraft carrier, have silicone rubber insulated cable installations in all fixed wireways. In every case, silicone rubber is chosen because it is virtually non-aging, stands up to intense heat better than any other flexible insulating material, and continues to operate even when subjected to fire.

●

There are many more places where G-E silicone rubbers' inherent properties can be vital in missiles, satellites and space vehicles. For further data, call your nearest G-E sales office or write Section **S81233 Silicone Products Department, General Electric Company, Waterford, New York.**

Progress Is Our Most Important Product

GENERAL ELECTRIC

New Electronic Products

Solar Cell

Solar cell resistant to damage by high energy radiation in space has been developed by the Department of the Army. The cell, of silicon, appears similar to present types, but the active layers are reversed. Cell is made by diffusing phosphorus into the surface of a "p-type" silicon crystal. Present cells are made by diffusing boron into an "n-type" silicon crystal.—Army Signal R&D Lab.

Circle 99 on postcard for more data

Star Tracking Device

Improved photomultiplier is well-suited for electronic star tracking. Unique image section design utilizes simple magnetic deflection

of the electron beam across a special internal aperture. Output is a greatly-amplified signal of the light received from stars providing error signals to operate matching servo drives. The equivalent noise input measured at 25°C is 5 x 10^{-11} lumen. This value may be reduced further if the cathode is operated at a lower temperature.—ITT Laboratories

Circle 100 on postcard for more data

High "G" Switch

Coaxial switch will withstand 50 G sustained acceleration and 20 G vibration from 75 to 2000 cps. It is now used on Polaris. Switch features miniaturization with a weight of only 75 grams, and a switching time of 0.006 sec. "Fail Safe" units are available for 6 to 30 VDC and 115 V 400 cycle AC operation with "TNC," "N" or "HN" coaxial connectors in an RF frequency range of 100 to 5000 mc.—Don-Lan Electronics.

Circle 101 on postcard for more data

Liquid Level Control

Sonoswitch affords a safe means of controlling liquid levels including corrosives or explosives. The explosion-proof stainless steel probe instantly actuates when any liquid touches its sensitive surface. Unit has a repeatability within thousandths of an inch. It does not actuate in foam or froth. The probe is capable of operating at pressures over 2000 psi.—Powertron Ultrasonics Corp.

Circle 102 on postcard for more data

Tape Code Converter

Code conversion is accomplished with the flick of a switch on new Punched Tape Code Converter. Five-, six-, seven-, or eight-channel code systems may be converted, one to the other, at 1180 codes per minute. Machine provides a two-way conversion link between the 8-channel Systems Flexowriter (shown in background) and such allied equipment as wire transmitters, computers, and address plate embossers.—Friden, Inc.

Circle 103 on postcard for more data

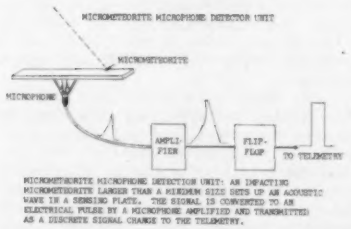
Quick Connector

"Quick Connector" makes connections to an entire row of studs in a terminal strip in a single operation. Can be used as a permanent connector, or as a tool in production circuit checking equipment. Unit is easily attached to test harnesses and cables such as is used in aircraft and missille production. Stock sizes with terminals to fit No. 6 and No. 8 studs are made with from 4 to 16 terminals.—Autotron Inc.

Circle 104 on postcard for more data

Detect Micrometeorites

Three methods of micrometeorite detection are contained in a single system. Most widely used technique is that of placing a sensitive



MICROMETEORITE MICROPHONE DETECTION UNIT: AN IMPACTING MICROMETEORITE LARGER THAN A MINIMUM SIZE SETS UP AN ACOUSTIC WAVE IN A SENSING PLATE. THE SIGNAL IS CONVERTED TO AN ELECTRICAL PULSE BY A MICROPHONE AMPLIFIED AND TRANSMITTED AS A DISCRETE SIGNAL CHANGE TO THE TELEMETRY.

crystal microphone directly in contact with some exposed surface of rocket or satellite. The second technique is the grid wire. This method is extremely simple and involves only measuring the continuity of a resistance wire. The thin film is the third technique. The film is placed over a pressure cell; by means of an aneroid switch the rate at which the air leaves the cell is measured after a micrometeorite strikes the exposed area.—Action Labs Inc.

Circle 105 on postcard for more data

Aerial Camera

Rapid processing system develops aerial reconnaissance roll film in two min. Unit attaches to camera. System uses a single solution containing developer and fixer which is used to impregnate a specially prepared web. As the film

. . . continued next page

New Electronic Products

is exposed, the web is pressed to the film and immediately begins developing. The negative cannot be under or over-developed. First field tests by Air Force have been successful—Chicago Aerial Industries.

Circle 106 on postcard for more data

UHF Mesa Transistors

Germanium mesa transistor series is for communications applications. Series features low noise figures with f (max) in excess of 1000 mc. Engineered to provide a rugged and reliable device for applications as r-f amplifiers, oscillators or intermediate frequency amplifiers in transceivers and communications equipment.—Texas Inst.

Circle 107 on postcard for more data

Ignition Analyzer

A "pulse divider" is available for the test and analysis of internal combustion piston or jet engine ignition systems. Designed to minimize the loading of the igniter, the unit is said to withstand pulses in excess of 40 kilovolts. The constant attenuation ratio allows reproduction of present-day ignition pulses with an amplitude error of less than 2 per cent. It is equipped with a connecting lead that mates with any modern high speed oscilloscope.—Harco Labs., Inc.

Circle 108 on postcard for more data

Gang Channel

New "tap-out" gang channel is for use on jet engines and other high temperature applications. Life of the locknuts permits great re-usability. Locknuts can be removed easily, without special tools, where installation damage makes inspection or replacement necessary. Individual inspection and replacement of nuts is possible.—Kaynar Mfg. Co.

Circle 109 on postcard for more data

SILICONE NEWS from Dow Corning

Helping a Hustler Hustle

A simple "short" due to insulation failure can ground or make impotent the B-58 Hustler, this nation's present promise of devastating reprisal. That's why Convair engineers specified Silastic®, the Dow Corning silicone rubber, as the insulation for power and control cable.

One moment this super-sonic guardian is streaking through the arctic cold and ozone-containing atmosphere above 50,000 feet . . . minutes later it may be standing in the oven heat of a desert landing strip . . . tough environments for any rubber insulating material — except Silastic.

Write to Dept. 0312 for information

first in silicones

Dow Corning CORPORATION
MIDLAND, MICHIGAN

Circle 26 on Inquiry Card

WHAT MORE DO YOU WANT GRAPHITE TO DO FOR YOU?

Graphite has been useful in aircraft and missile problem-solving as a component material in rocket motors, in brazing fixtures for airframe construction, and in other refractory applications.

Further and more advanced uses of graphite in space age progress may well be developing now as part of your design engineering program.

As one of the world's largest producers of high quality graphite, we would welcome having our engineers and technicians work with you on these developments.

May we have the pleasure of hearing from you?

PRODUCTS ELECTRODE GLC DIVISION YOU CAN TRUST ®

GREAT LAKES CARBON CORPORATION

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Circle 27 on Inquiry Card

Designed, manufactured and environmentally tested specifically for use on ROCKETS, SATELLITES and BALLOONS.

FEATURES:

- A completely packaged unit with electronics, mechanics and optics ready for operation.
- Available with accuracies from minutes to seconds of arc.
- Small, lightweight and low power required.
- Self-pointing with payloads ranging from 10 to 100 lbs. for use on vehicles with spin rates up to 2 rps.

The ALI Sun Seeker and Sun Sensor are highly sensitive devices for guidance, pointing experiments, tracking and sensing. Typical of their many uses are in association with telescopes, spectrographs, cameras and cosmic ray detectors.

A Sun Seeker with an accuracy of 1 minute of arc weighs only four pounds, and has a power consumption of 1 watt.

A Sun Sensor with an accuracy of 1 minute of arc weighs 1 lb. and has a power consumption of 0.2 watts.

Pointing controls and electronics are readily adapted for Ultra Violet and Infra Red sensing heads.

For further information write

ACTON LABORATORIES, INC.
A Subsidiary of
TECHNOLOGY INSTRUMENT CORP.
533 MAIN STREET, ACTON, MASS.

Circle 28 on Inquiry Card

Command-Destruct Receiver

A transistorized UHF command-destruct receiver has been designed for use in missile environments. Specialized applications are in the field of target missile or drone radio command systems. The Model 2620 requires only 1.5 watts of input power. It operates in the 400 to 550 megacycle range, has a sensitivity of 5.0 microvolts, a total volume of 16.8 in.^{3} and a weight of 1 lb.—R S Electronics Corporation.

Circle 110 on postcard for more data

Subcarrier Oscillator

Model 10087 oscillator offers a linearity within 0.1 per cent of bandwidth, and a frequency and sensitivity stability within 0.3 per cent over the temperature range of 0 to 85°C, and 0.6 per cent from −18°C to 100°C. Characteristics include: Input signal—0 to 5v or = 2.5v for full deviation; input impedence—100 K ohm; output signal amplitude—0 to 2 v RMS; power requirements—28 vd.c ±10 per cent at 14 ma. nominal. Size 1.6.x1. 43x1.87 in.; weight 5.3 oz. —Hoover Electronics Co.

Circle 111 on postcard for more data

Temperature Chamber

Precision temperature test chamber can accomodate rack-mounted electronic equipment for prolonged temperature runs with stability to within ½°F over the range —100°F to 500°F. Described as Model 7000A, the chamber has an internal test volume of 19½ x 11 x 15 in. easily handling the 19-in. standard rack unit. Chamber can be preset for automatic hot-cold cycling at alternate temperature levels throughout its range. Aluminum cabinet is finished in gray wrinkle enamel; interior is of stainless steel. CO_2 is used for cooling. The chamber is supplied with a Pyrex window. — Delta Design, Inc.

Circle 112 on postcard for more data

operates 1000 hr at 1000°F
. . . hermetically sealed

Here is an entirely new, hermetically sealed solenoid that may open up many important new design avenues for you. Rated for twice the life of previous models . . . can be used with electromechanical devices operating at temperatures previously nonaccessible. Special ceramic protective coating helps unit achieve a guaranteed life rating of 1000 hours at 1000°F. Priced substantially lower than present non-hermetic units on the market.

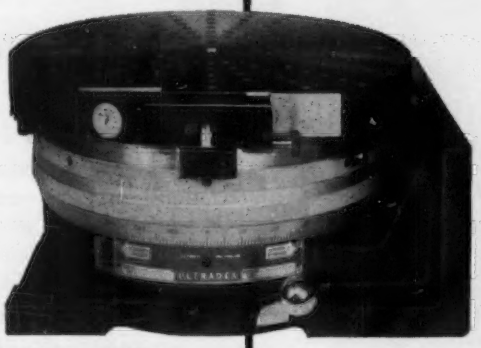
CHARACTERISTICS

Operating temperature—to 1000°F
Plunger travel—.020"
Average output force at 8 watts & 1000°F—1.5 lb
Average output force at 100 watts & 1000°F—2.7 lb
Weight—.28 lb
Meets requirements MIL-E-5272C

Consult the Barber-Colman engineering sales office nearest you: Baltimore, Boston, Dayton, Fort Worth, Los Angeles, Montreal, New York, Rockford, San Diego, Seattle, Winter Park, Florida.

BARBER-COLMAN COMPANY
DEPT. L, 14109 ROCK STREET, ROCKFORD, ILLINOIS

Circle 29 on Inquiry Card



Ultradex high precision indexing table

"In-Process" Inspection to Millionths

Inspecting a workpiece with laboratory accuracy while mounted in machining position greatly reduces scrap in high precision missile components. The Ultradex provides this checking ability while, at the same time, serving as a machining fixture. The Ultradex has a radial locating and indexing accuracy of ¼ second of arc, or six millionths of an inch at a one-foot diameter. Table surface is flat and parallel within 0.000050 inches. Large 12″ diameter with ample radially dispersed threaded holes permits easy attachment of workpieces or fixtures. Sealed design allows use in operations requiring coolants or lubricants.

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CON-O-PAK THERMOCOUPLES
FROM -300°F TO 4000° PLUS
The world's finest thermocouples. New process increases precision and temperature range. Exceeds all military and commercial specs. Con-O-Pak is used in aircraft, missiles, nucleonics, chemical processing. Useful data? . . . Ask for "The Con-O-Pak Story."
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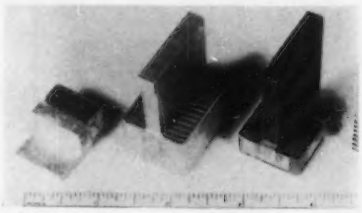
NOW in 50 WATTS for MINIATURE and SUBMINIATURE PRODUCTION SOLDERING JOBS
the NEW, American Beauty BANTAM "X" series
⅛" TIP
Designed with 50 watt input, these fine soldering irons will give greater productivity and do industry's most exacting soldering jobs easier, faster, better. SLOTTED STAINLESS STEEL CASINGS MAKE THE HANDLES REALLY COOL, ending operator complaints. There's no waiting or fumbling with these light, flexible tools — they're always ready. American Beauty soldering irons are known the world over for their dependability, durability and efficiency. Learn more about these fine soldering tools today.
Shown below are other shapes and tip-size irons available in the BANTAM "X" series.
YOU CAN'T BEAT A SOLDERED CONNECTION
WRITE FOR DESCRIPTIVE CATALOG SHEET, FORM NO. 222-CT
3/16" TIP
204-B
AMERICAN ELECTRICAL HEATER COMPANY
DETROIT 2, MICHIGAN
American Beauty

New Parts and Components

Heat Dissipators

Miniaturized heat dissipators for cooling transistors and other solid state electronic packages in airborne and ground support equipment use gas or air as a cooling medium, eliminating the need for ducts or



tubes. Designated Model T, they are available in various sizes and shapes to fit specific customer requirements. Capacities range from 1 to 10 watts and thermal resistance can be as low as 1°F, with pressure losses as low as 0.025-in. H_2O. They are designed to become an integral part of the electronic unit to be cooled.—Horkey-Moore Associates

Circle 113 on postcard for more data

Sequence Timer

Miniature timer is designed specifically for rocket, missile, and satellite use, to provide switch closures during and after powered flight. Measures 1½ x 2½ x 3 in. and weighs 11 oz. Accuracy is better than 3 per cent; quick-set, easily-accessible cams are micro adjustable within 0.1 per cent of the total period; an adjustable time span of 1 sec to 45 min can be selected. Less than 70 milliamp current is needed for operation. Multiple switch closures can be designated. Model 4-23 provides eight but a greater or lesser number are available. They surpass MIL-E-5272C specifications for vibration, shock and acceleration.—Action Laboratories.

Circle 114 on postcard for more data

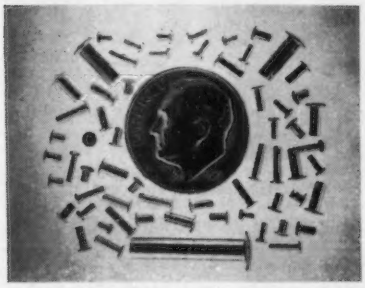
Hydraulic Filter

Line-type filter is for installation on suction or return line. Applicable to requirements of operating pressures up to 250 p.s.i. at temperatures up to 300°F. Now being produced in capacity sizes of 10, 20,30,50 and 75 G.P.M. with choice of Monel wire cloth mesh sizes from 30 to 200. All units are available with or without by-pass valve.—Marvel Engineering Co.

Circle 115 on postcard for more data

Microminiature Rivets

Intended for instrument, electronic, and printed-circuit applications these rivets are electroplated with 24-carat gold. Partially-hollow shanks offer combined advan-

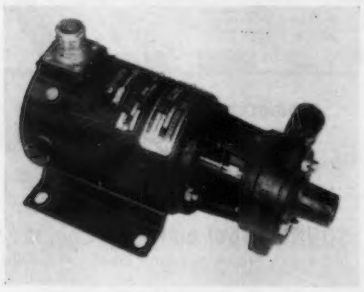


tages of both solid and tubular rivets. Brass material plated with shot-burnished gold prevents "platter" of particles during setting or clinching. Lengths range in 1/32-in. increments down to 1/32 in.; over 40 sizes are standard.—Circon Component Corp.

Circle 116 on postcard for more data

Centrifugal Pump

Driven by a 1/10 hp motor, Model E-1, Type 250 centrifugal pump feeds fuel to a Boeing turbo-compressor that supplies hot compressed air to start aircraft jet engines. The pump delivers 1½ gpm at 15 psi. Shut-off pressure is



21 psi; 28 volt d.c. motor operates at 8700 rpm and forms an integral part of the pump. Bronze construction and a special mechanical type rotary seal enables this pump to handle a variety of fluids with equal safety and efficiency.—Eastern Industries.

Circle 117 on postcard for more data

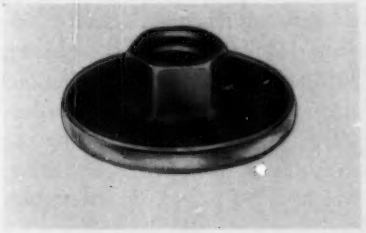
Tube Connector

Uses mechanical attachment to tubing without beading, flaring, or welding, features a re-usable seal. Connector is about 1/5 the weight of AN connector and can be coupled and uncoupled by hand, without tools. Available in sizes from ¼ through 2 in. for a temperature range of —70° to +450°F., for almost all fluids and gases. Special connectors are also made for —400°F and 1200°F applications. —Gamah Corp.

Circle 118 on postcard for more data

Captive-Washer Nut

Lightweight, self-locking nut used on terminal blocks has an integral, free-spinning washer that completely eliminates the possibility of a washer dropping off into places



where it might do damage. Principle allows placing of terminals closer together, and requires less wrench clearance.—Kaynar Mfg. Co.

Circle 119 on postcard for more data

Improved Photography

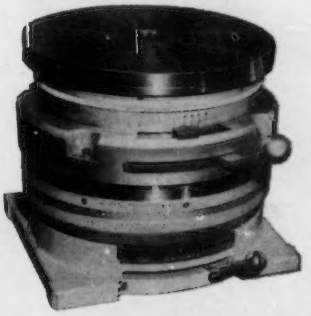
New research tool is giving astronomers previously unobtainable data in astronomical photography and tracking. The device is called a photoelectric image intensifier, or image tube. Tubes have already increased telescope speeds by as much as 30 times, and have the potential of increasing them by a factor of 100.—National Science Foundation.

Circle 120 on postcard for more data

ACCURATE
ANGULAR INDEXING to 1/4 SECOND OF ARC with ©MILICHEX

ROTARY INDEXING TABLES

Designed to provide indexing accuracies of ¼ second of arc, Milichex tables are available in many models and combinations to fit almost any need, including angular indexing to minutes and seconds. (1,296,000 positive settings within a full circle.) "Laboratory" accuracy to within 12-millionths of an inch at a 20 inch diameter is possible.



This Model M2X-900 Milichex allows quick setting to any full or fractional angle in ¼ degree increments on a production basis. Operator merely sets tables to two marks. They automatically lock into correct setting.

All Milichex models are flat and parallel within 0.000050 inches and provided with numerous threaded holes for easy mounting of workpiece or fixtures. Milichex tables can be used also for checking roundness or concentricity within 10-millionths.

For details write for Bulletin X-60

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First, imaginative design; then experienced thoroughness through development, tooling, production, assembly and tests, all under strict quality control in an unusually well equipped plant . . . we can help you solve your special problems . . .

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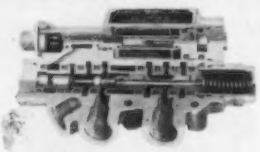

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WRITE, wire, or phone for data, quotations and service.

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Circle 34 on Inquiry Card

New for Production

Metal-shaping Process

Electroshaping is called potentially capable of duplicating all present metal-shaping operations.

Metal workpiece is held in special fixture. Solution is then flowed between workpiece, which becomes the anode, and electrodes on each side of workpiece. Electrodes become the cathodes in the electrolytic circuit. They are moved closer together as operation progresses and workpiece is gradually worked to final configuration.

This "Sifco" process is believed well-suited for tungsten, molybdenum, the superalloys, and cemented carbides. It is now being applied to compressor blades and to some tooling work.—The Steel Improvement and Forge Co.

Circle 121 on postcard for more data

Punch Riveter

Riveting machine is said to operate 11 times as fast as existing methods. It performs all operations automatically "in less than two seconds." This includes punching the hole, placing the rivet and heading. Weight is 50 lb.—ACF Electronics Div.

Circle 122 on postcard for more data

THE LIGHT THAT TURNS CORNERS

2 LIGHTS IN 1

LIGHTS UP AREAS NO OTHER FLASHLIGHT CAN

- Lights up hard-to-check areas
- Solves tough inspection problems
- Powerful 1000 ft. fixed focus beam
- Pin Point beam goes on automatically when you raise flexible extension

No. 77LP sealed in steel guaranteed leakproof USALITE batteries.

DUO-FLEX FLASHLIGHT No. DF-22 Patented

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UNITED STATES ELECTRIC MFG. CORP.
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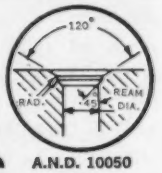
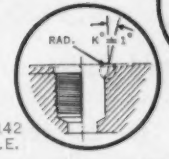
Circle 35 on Inquiry Card

Do you machine hydraulic parts?



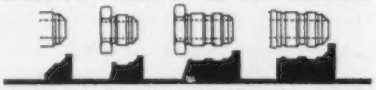
A.N.D. 10050

MS33514
or MS33515

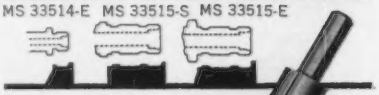


MS 16142
or S.A.E.

MS33656-G MS33656-E MS33657-E MS24386-E MS33657-S MS24386-S



MS 33514-E MS 33515-S MS 33515-E



Standard cutters in stock for immediate delivery.
Write for catalog.

SONNET Tool and Mfg. Company
580 North Prairie Avenue • Hawthorne, Calif.

Circle 36 on Inquiry Card

Vibration Exciter

Complex wave vibration exciter is designed for rapid checkout of production line items. It meets the requirements specified by Martin-Denver in their acceptance testing program for Titan B.

Designed by Convair-Astronautics and manufactured by Rototest Laboratories, this "Rotocon" analyzer supplies wide band complex vibration to payloads up to 120 lb without the need for complicated control or monitoring systems.—Rototest Laboratories.

Circle 123 on postcard for more data

Finds C. G.

The "Cee-Gee Locator" positions center of gravity of test specimen and fixture axially along center of force within 10 gram inches. Capacity of model is 50 lb. Larger capacity units available. — Auto-Control Laboratories, Inc.

Circle 124 on postcard for more data

Test Console

Flight line test console meets military requirements, and is available in multiple bays. It is mounted on heavy-duty dollies suitable for towing over airfield paving. Console accepts standard 19-in. electronic chassis—EIA mounting provisions. Swing-up work bench surface locks in horizontal position. Cabinet is 51.3 in. high, 36 in. deep. Comes with MIL or special finish.—Western Devices, Inc.

Circle 125 on postcard for more data

Boring Machines

Two double-end and two single-end standard precision boring machines, models 731, 732, 751 and 752, are available.

The new line of horizontal hydraulically-operated machines provides maximum dimensional stability under all kinds of operating conditions. Features include:

- Temperature - controlled hydraulic panels
- Redesigned bases
- Strengthened machine tables.—Ex-Cell-O Corp.

Circle 126 on postcard for more data

Continued on next page

AT A FRACTION OF THE SIZE and weight of competitive heavy-duty units, this compact portable gives you 50 to 100 watts effective cleaning power per gallon! Transistorized circuitry is one reason; another is the exclusive 90%-efficient Multipower transducer—a transducer more efficient by far than any other on the market!

YOU GET THREE SYSTEMS IN ONE! Only Acoustica offers you variable control of three tuned power levels—from gentle washing to high-energy scrubbing!

ACOUSTICA'S TUBELESS CIRCUITRY means virtually trouble-free performance ...and cleaning action that starts the instant you flick the switch.

COMPLETELY SELF-TUNING, these new units are extremely easy to operate. No meters to read, no adjustments to make, no monitoring necessary.

WHERE OTHER METHODS WON'T WORK—where the slightest contaminant in a small, complex device can impair reliability and cause rejects—Acoustica systems do the job thoroughly and quickly. Even in ordinary applications, Acoustica cleaning often proves superior because of the savings it makes possible in time and labor. Wherever ultrasonic cleaning is the answer, an Acoustica system is the best answer.

WRITE FOR COMPLETE OPERATING SPECIFICATIONS

acoustica

ACOUSTICA ASSOCIATES, INC.

10400 Aviation Blvd., Los Angeles 45, Calif.

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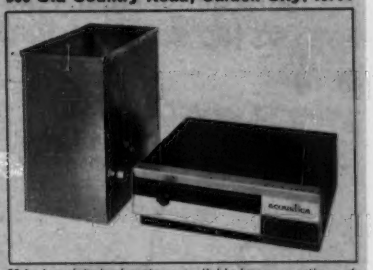


20 kc transistorized systems available in power ratings of 250, 500, 1000 watts; tank sizes of 3, 5, 10 gallons. Integral tank-transducer combinations available.

UP TO THREE TIMES THE ULTRASONIC CLEANING POWER—IN ONE-THIRD THE SIZE

NEW 20KC TRANSISTORIZED CLEANING SYSTEMS BY ACOUSTICA!

Circle 37 on Inquiry Card

AIR He N

COMPRESSION to

12,000 psi

...discharge capacities to 150 scfm

with

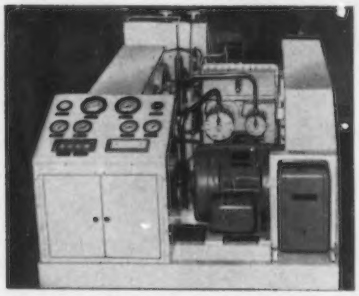
CARDAIR
CENTRAL COMPRESSION SYSTEMS

New Technical Data and Catalog. See offer below.

Cardair Central Compression Systems (completely packaged, semi-portable)—are today handling air and a variety of gases—helium, nitrogen, argon, etc.—at pressures ranging from 4,000 to 12,000 psi with discharge capacities from 50 to 150 scfm. Even hydrogen is being safely compressed to elevated pressures.

Systems can be provided from stock with *guaranteed* purification of delivered gas to —100°F. dew point and less than 4 ppm oil content. Specially engineered systems to meet your particular requirements can be supplied from standard components.

This performance is *demonstrated* by exacting rocket and missile service and continuously growing use by prime contractors, suppliers of missile components and controls, and testing laboratories. It is *backed* by over 20 years of compressor design and application experience.



Model PB-CCS—*One of a wide selection of systems* 4-stage air-cooled Compression System—Pressure Range: 6,000—12,000 psig—Induction: 65 to 135 psig—Capacity: 75 scfm N_2 and Air; 70 scfm He—Guaranteed Gas Purity: —100°F. Dew Point, less than 4 ppm oil content.

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Circle 39 on Inquiry Card

New for Production

. . . continued

Chromizing Process

Jet engine blades, vanes and other components are given improved oxidation and scaling resistance by a new chromizing process called Alphatizing. Some of the metals treated are molybdenum, tungsten, nickel and cobalt-base alloys. Process uses Alphalloy, a granular compound. This is placed in treating vessel along with parts to be processed. Through the action of heat, proper chromizing atmosphere is produced. The chromium penetrates into the surface of the treated parts to form a true alloy.—Alloy Surfaces Co.

Circle 127 on postcard for more data

Carbide Planing

The Flying Scot is an openside planer developed in response to industry's need for an accurate, extremely rugged planer in the low-priced field.

Table speeds range from 30 to 300 f.p.m.; 60/75 h.p. variable voltage drive produces 10,000 lbs. table thrust. The openside feature facilitates the handling of unusual jobs.

Available in nine combinations of table widths and heights. Basic sizes are 30 in., 36 in. and 42 in. —The G. A. Gray Co.

Circle 128 on postcard for more data

Tapping Head

Lead screw tapping head enables unskilled help to produce precision tapped holes on any drill press. Unit features a rapidly interchangeable lead screw, a sensitive cone clutch that runs in oil, and a positive depth control which assures perfect threads even in blind or recessed holes. A hardened precision ground lead screw runs in a special alloy bronze nut. This is adjustable to compensate for wear. Rubberflex collect center taps accurately in relation to centerline of lead screw. —Ettco Tool & Machine Co.

Circle 129 on postcard for more data

ballistics with statistics

Behind the launching pad lie years of statistics.

And years of statistical specialization have given Wall tubing reliability in meeting the critical test. Exhaustive testing assures that Wall Tube's stainless steel, nickel and nickel alloy tubing will be of the highest quality.

Before you procure small diameter tubing of any grade, let a Technical Sales Representative demonstrate Wall Tube's know-how—that developed from demanding application.

RANGE OF MANUFACTURE

Stainless Steel—Welded and Cold Drawn—1/8" OD to 3 32" OD, .083 to .008 walls. Seamless—5/8" OD to 3 32" OD, .049 to .008 walls. Nickel and nickel alloy—seamless, 5/8" OD to 3 32" OD, .049 to .008 walls.

WALL TUBE AND METAL PRODUCTS CO.

NEWPORT, TENN.

Circle 38 on Inquiry Card

Circle 40 on Inquiry Card ➔

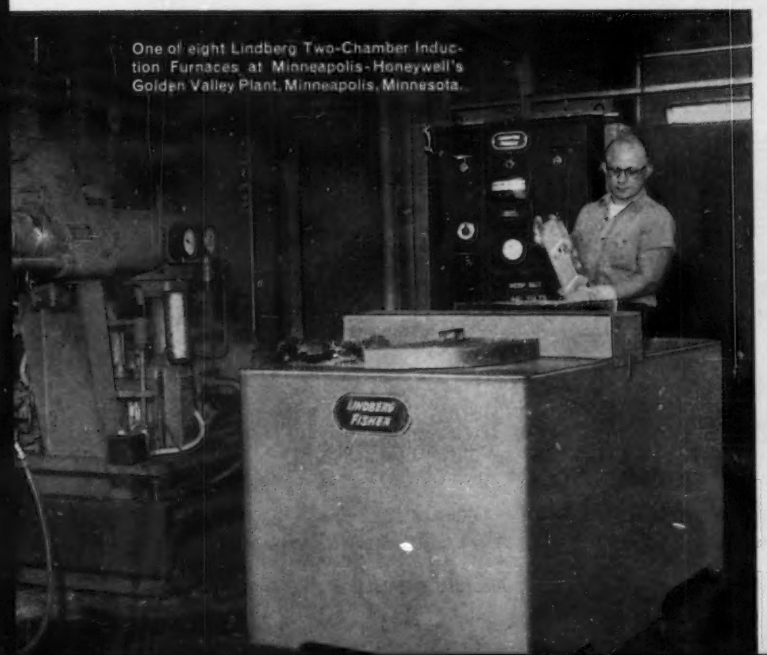
ART GEORGE has a good word to say for Lindberg Melting Furnace performance

QUOTE

Mr. Art George, Senior Production Engineer, Golden Valley Plant, Minneapolis-Honeywell Regulator Company, Minneapolis, Minn.

"Our installation of eight* Lindberg-Fisher Two-Chamber Induction Melting and Holding Furnaces has given remarkable service for more than four years. In this period, with the help of a well executed Honeywell maintenance program, the installation has been unusually trouble-free. Only one of the eight furnaces has required relining over this long period. Handling more than 1,000,000 pounds of aluminum and zinc annually, the installation has unfailingly provided the consistently high quality of metal our precision instruments require."

**Altogether, 44 Lindberg Furnaces are in operation in various Honeywell plants.*



One of eight Lindberg Two-Chamber Induction Furnaces at Minneapolis-Honeywell's Golden Valley Plant, Minneapolis, Minnesota.

These eight Lindberg-Fisher Induction Furnaces melt and hold aluminum and zinc for die casting gas valve housings and other component parts. They are located at the die casting machines where ingot and scrap can be melted and held at the desired casting temperature in one convenient unit. Magnetic fluxing and stirring insures uniform temperatures and consistently clean metal.

In any production process where aluminum needs heat there is Lindberg equipment to apply it most economically and efficiently. Furnaces for melting and holding, casting stations, re-melting or heat treating are available in all capacities, electric or fuel fired. Get in touch with your Lindberg Field Engineer (see your classified phone book) or write us direct. Lindberg-Fisher Division, Lindberg Engineering Company, 2473 West Hubbard St., Chicago 12, Illinois.

Los Angeles plant: 11937 S. Regentview Avenue, Downey, California. In Canada: Birlefco-Lindberg Ltd., 15 Pelham Ave., Toronto 9, Ont. Also, Lindberg plants in Argentina, Australia, England, France, Italy, Japan, South Africa, Spain, Switzerland and West Germany.

LINDBERG
heat for industry

TubeXperience in Action

TUBING WITH PAPER-THIN WALLS

cuts weight, improves efficiency in vital aircraft heat exchangers

Light weight, fast heat transfer, good corrosion resistance, ease of working and brazing, high ductility, good flarability, good shock resistance, and consistent uniformity are prime requisites of the small-diameter tubing used in the fabrication of airborne heat exchangers. Superior miniature heat exchanger tubing meets all these requirements. Here are some of the reasons for its wide acceptance in the field:

Made from a wide selection of stainless steels. These include Types 304, 310, 316 and 347, plus two low-carbon analyses, Types 304L and 316L, which minimize carbide precipitation and are not subject to carbide embrittlement.

Held to extra close tolerances. Superior can hold tubing to one-half commercial tolerance, or closer, when specified. OD sizes as small as 3/32 in. and walls as thin as .004 in. can be produced.

Given careful surface inspection. Statistical sampling or 100% inspection.

100% pressure tested and statistically flare tested. Standard on Superior's miniature heat exchanger tubing—and many other types where high ductility is needed.

Available in a number of different shapes. Squares, rectangles, ovals, ellipses, etc., can be produced to meet the latest aircraft heat exchanger design requirements.

If you need the reliability that assures fast, efficient heat transfer, light weight, and consistently safe performance under any operating condition, specify Superior. Write for Bulletin 372—it gives detailed information on all types of Superior tubing for aircraft, missile and rocket applications. Superior Tube Company, 2053 Germantown Ave., Norristown, Pa.

Superior Tube
The big name in small tubing
NORRISTOWN, PA.

All analyses .010 in. to 3/8 in. OD—certain analyses in light walls up to 2½ in. OD

West Coast: Pacific Tube Company, Los Angeles, California • FIRST STEEL TUBE MILL IN THE WEST

Industry Notes

Grumman Developing First OAO Satellite

Hardware for the first research in the Orbiting Astronomical Observatory program is now being developed by Grumman Aircraft Engineering Corp. under NASA contract.

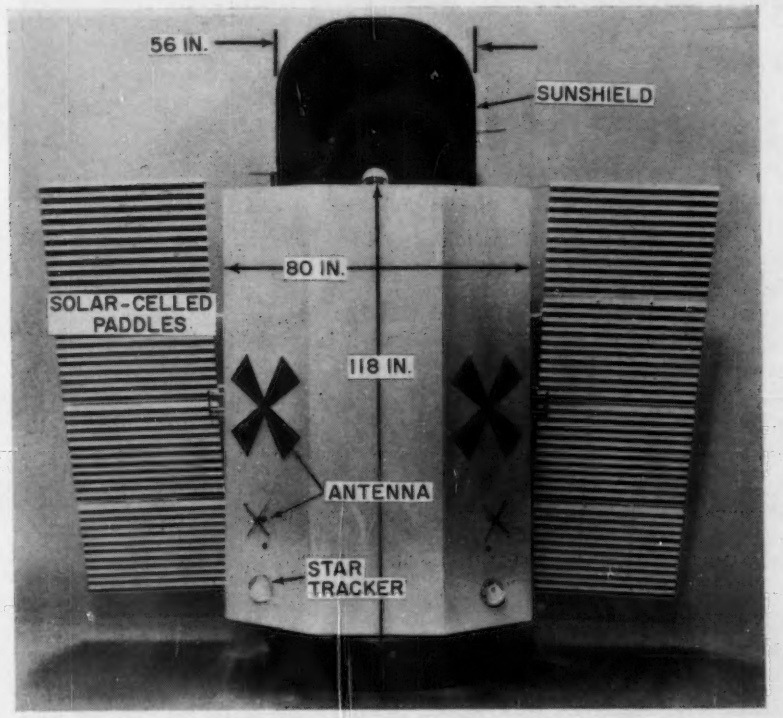
Grumman's design calls for an eight sided satellite with aluminum body and titanium skin. Dimensions: 9½ ft high, 6½ ft diam. Weight: about 3200 lb, including 1000 lb of experimental equipment.

Astronomical equipment with reflecting mirrors up to 36 inches in diam will be mounted in a cylindrical chamber running through length of the OAO. Celestial studies will be made at about 500 miles, above the atmospheric layers which absorb the ultraviolet and infrared portions of the spectrum. Predicted lifetime of first OAO: one year.

Grumman is developing two flight model OAO's. The first is to be delivered in 2½ years for late 1963 launch using Atlas-Agena B. The scientific program, a step beyond the current high altitude balloon studies will advance the state of the art in satellite orientation and further knowledge of the universe. OAO must be able to lock on a celestial body with accuracy of 0.1 sec of arc. This limiting accuracy is several orders of magnitude more demanding than anything done to date.

Plans for future satellite astronomy include:

- 5000 lb satellites in 24 hours, 22,000 mile-high orbits over fixed points on the equator. This plan is being studied at Kitt Peak National Observatory for the National Science Foundation. It calls for initial launch, using Saturn, about 1965. Satellites would bear 50 inch telescopes and would have 3-5 year life.
- Large unmanned observatories assembled in orbit. Astronomers hope to assemble telescopes with lens diam exceeding Mt. Palomar's 200-inch diameter.



OBSERVATORY MODEL shown at Grumman Aircraft's Bethpage, L. I., headquarters. Telescope system runs through center of eight-sided structure.

Orienting An OAO

A system of reaction wheels and nitrogen jets is generally considered feasible for moving a satellite into a fine point on a star.

Under this system, the "muscles" of the orientation process are three reaction wheels with dual motor windings. Satellite has opposite reaction to movement of wheel, which is connected to motor shaft. Satellite motion is stopped by expelling nitrogen from nozzles on satellite periphery.

Positioning sequence is believed to entail:

- General orientation for ground astronomers by means of television linkage. Ground signals then begin pointing satellite on a particular star. Satellite verifies commands and stores them for execution as long as two hours later.
- Star trackers detect errors in positioning and signal the control system "muscles." Grumman's OAO will include six star trackers. These measure pitch and yaw angles between direction of the primary optical axis with respect to the sun and direction of a known reference star in the field. Grumman uses four sun sensors in aligning satellite to sun.

Silicon cells on surface of paddlewheels provide photoelectric power for operating motor. Nickel

continued on next page

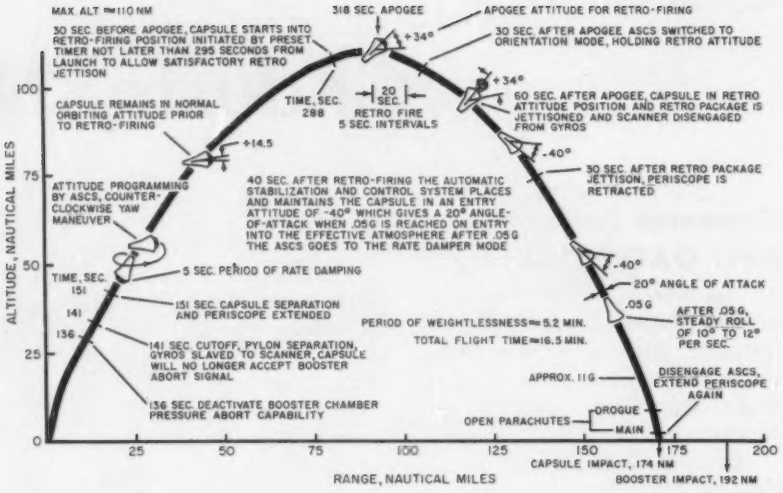
Industry Notes

. . . *continued from page 73*

cadmium batteries store energy.

Grumman's design must compensate for disturbance torques from the paddlewheels which result in some solar radiation pressure and atmospheric drag. Likewise, even the interaction between earth's magnetic field and magnetic materials in the satellite must be considered.

A sunshield casts a shadow over the telescope aperture. This prevents solar data from interfering with studies. The shield folds over the aperture if shield is at less than a 45° angle to optical axis between sun and satellite.


MAX. ALT ≈110 NM
318 SEC. APOGEE
APOGEE ATTITUDE FOR RETRO-FIRING
30 SEC. BEFORE APOGEE, CAPSULE STARTS INTO RETRO-FIRING POSITION INITIATED BY PRESET TIMER NOT LATER THAN 295 SECONDS FROM LAUNCH TO ALLOW SATISFACTORY RETRO JETTISON
30 SEC. AFTER APOGEE, ASCS SWITCHED TO ORIENTATION MODE, HOLDING RETRO ATTITUDE
+34°
+34°
60 SEC. AFTER APOGEE, CAPSULE IN RETRO ATTITUDE POSITION AND RETRO PACKAGE IS JETTISONED AND SCANNER DISENGAGED FROM GYROS
CAPSULE REMAINS IN NORMAL ORBITING ATTITUDE PRIOR TO RETRO-FIRING
TIME, SEC. 288
20 SEC. RETRO FIRE 5 SEC. INTERVALS
+14.5
-40°
30 SEC. AFTER RETRO PACKAGE JETTISON, PERISCOPE IS RETRACTED
ATTITUDE PROGRAMMING BY ASCS, COUNTER-CLOCKWISE YAW MANEUVER
40 SEC. AFTER RETRO-FIRING THE AUTOMATIC STABILIZATION AND CONTROL SYSTEM PLACES AND MAINTAINS THE CAPSULE IN AN ENTRY ATTITUDE OF -40° WHICH GIVES A 20° ANGLE-OF-ATTACK WHEN .05G IS REACHED ON ENTRY INTO THE EFFECTIVE ATMOSPHERE AFTER .05G THE ASCS GOES TO THE RATE DAMPER MODE
-40°
20° ANGLE OF ATTACK
5 SEC. PERIOD OF RATE DAMPING
TIME, SEC.
151
141
136
151 SEC. CAPSULE SEPARATION AND PERISCOPE EXTENDED
.05 G
AFTER .05 G, STEADY ROLL OF 10° TO 12° PER SEC.
PERIOD OF WEIGHTLESSNESS≈5.2 MIN.
TOTAL FLIGHT TIME≈16.5 MIN.
141 SEC. CUTOFF, PYLON SEPARATION, GYROS SLAVED TO SCANNER, CAPSULE WILL NO LONGER ACCEPT BOOSTER ABORT SIGNAL
APPROX. 11G
DISENGAGE ASCS, EXTEND PERISCOPE AGAIN
136 SEC. DEACTIVATE BOOSTER CHAMBER PRESSURE ABORT CAPABILITY
OPEN PARACHUTES
DROGUE
MAIN
ALTITUDE, NAUTICAL MILES
0
25
50
75
100
25
50
75
100
125
150
175
200
CAPSULE IMPACT, 174 NM
BOOSTER IMPACT, 192 NM
RANGE, NAUTICAL MILES

MERCURY-REDSTONE is slated to follow this sequence for suborbital flight in early 1961.

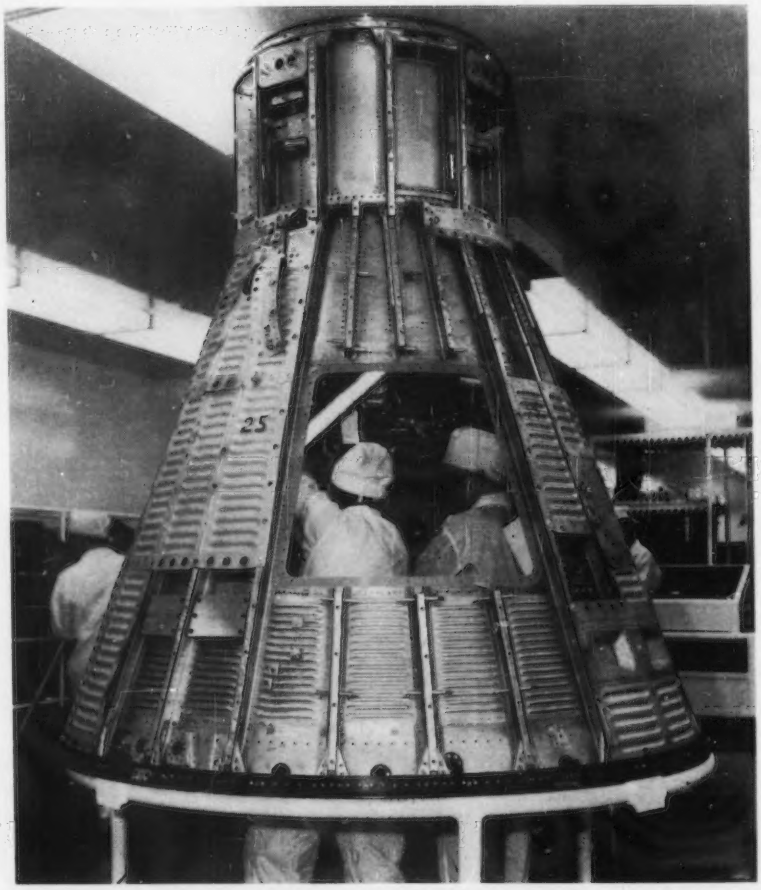
Apollo Design Studies

Basic objectives of Project Apollo design studies at Martin Co., General Electric Co. (MSVD), and Convair-Astronautics:

- Define a manned spacecraft system meeting Apollo mission requirements of providing for reconnaissance flights to vicinity of the moon and advances toward establishment of manned space station.
- Implementation plan with estimates of time, costs, and facilities for design, development and production.
- Identification of problem areas that might demand long research and development lead-time.
- Funding study. Preliminary estimates predict that NASA will spend $250-million per year on Apollo over a ten year period.

The three study contracts, $250,000 each, are to be completed by June.

Apollo program may cost $3,500,000,000 over the next ten years. NASA reportedly plans to spend about $3.5-million a year on the project, which may send a three-man spaceship around the moon and back by 1969. Development contract is expected next Summer.



MERCURY CAPSULE being fabricated at McDonnell Aircraft. Firm reports that inner and outer shell of conical afterbody are now of nickel alloy (René 41). Shells are seam-welded together. Beryllium shingles are used on narrow apex for protection during launch through the atmosphere. Pressure vessel opening will contain four-layer window with polaroid filters.

Space Uses Seen For Plastic Foam

Pre-mixed, one-part frozen urethanes of 1½ or 2 lb density are being studied as possible self-fabricating escape capsules for Dyna-Soar and Apollo pilots.

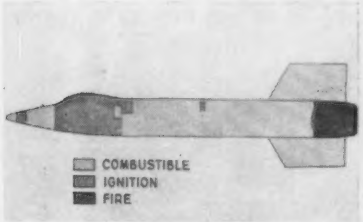
A pre-mixed frozen urethane condensate may also be used for preliminary manufacture, in orbit, of plastic film inflatable structures. These would expand spontaneously at low temperature and pressure, and could form rigid structure far more stable and durable than Echo.

Since the urethanes would be kept frozen until foam-expansion was desired, they would probably only be used as escape cocoons on relatively short missions. For longer intervals, a two-part urethane (resin + catalyst and mixer) would be used.

Under present state-of-the-art, escape capsule could be fabricated in orbit in several minutes, according to some estimates. Equipment would include:

- Pressure suit and parachute. Total weight of pilot's gear has been calculated as 240 lb.
- Ten lb 1½ ft long tank of urethane. Frozen foam would be kept frozen by liquid nitrogen and would probably require addition of some heat to accelerate expansion. Resistance elements could be embedded in place prior to expansion process. Two-part foam would require a second 10 lb tank of mixer. Two-part systems are often hampered by excessive viscosities of reactants in low temperature environments.

. . . more industry notes page 77



X-15 FIRE PREVENTION divides vehicle into separate zones for each fire element. Zones are oxygen source, combustion source, or ignition source.

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Industry Notes

. . . continued from page 75

R & D Briefs

Two transmitters on Ranger spacecraft will be of ¼ watt and 3 watt power output transmitting at frequency above 1000 mc. Venus/Mars mission transmitters for later vehicles seen at 350 watt output—sufficient for clear TV.

Geophysical instrumentation will be required for future space efforts. Hughes Tool, Kaman, and Texaco are already analyzing problems. By time Prospector vehicle is operational, systems are slated to return pure samples to earth for study.

Stabilization controls for orbiting astronomical observatories will be developed by Air Arm Div., Westinghouse Electric Corp.

Space guidance system advances required for JPL programs include: small high efficiency hot gas expulsion system for attitude control; simple momentum interchange device for cruise trim; computers with 60-70,000 hr. mean life with self healing failure features; pulse torquing accelerometers replacing analog to digital conversion through computers—digital output sensors; photovoltaic cells with 15% efficiency.

Apollo design concepts: One of the most promising is a saucer-shaped vehicle to carry three men in earth-orbit for one week or make a two-week roundtrip to the moon.

High strength alumina designed for high temperature metallizing is being introduced by Gladding, McBean & Co. Compressive strength is above 400,000 psi, and flexural strength above 45,000 psi. Max working temperature: above 1700°C.

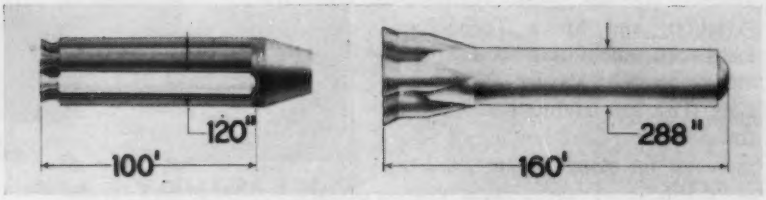
Large diam cases for solid propellant rockets are under research at The Budd Co. The Army asked the firm to investigate new high-strength materials and advanced methods of fabrication; and then build a full scale prototype. Program extends over three year period.

Second-stage boosters for future Transit and Courier launchings will be provided by Aerojet-General Corp. with Space Electronics Corp. as the major subcontractor. Boosters will be restartable Ablestar vehicles.

Shaft-seal research at Battelle Memorial Institute is gaining data on dynamic behavior of high-speed liquid-lubricated face seals. Leakage has plagued high speed turbomachinery of the type used as accessory equipment for commercial jets.

Latest Mercury attitude-tolerances being discussed at NASA's Space Task Group: 34 deg. instead of 17 deg. for normal orbit attitude.

Thrust augmenter using pyrophoric fuel has been developed at Continental Aviation and Engineering Corp. This lightweight afterburner uses a mixture of TEA and TMA; and operates at combustion velocities higher than regular JP-4 afterburners.



SOLID BOOSTERS for 7,000,000 lb gross weight spacecraft, according to Aerojet-General designs. Left, clustered booster; right, large single chamber booster.

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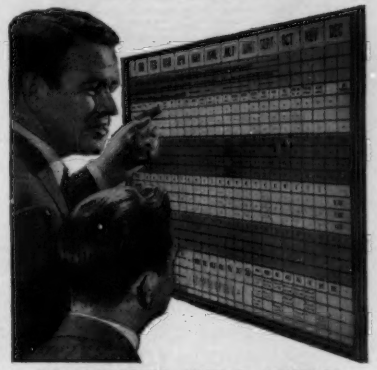

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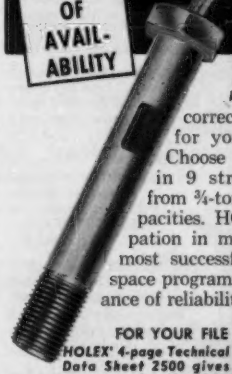

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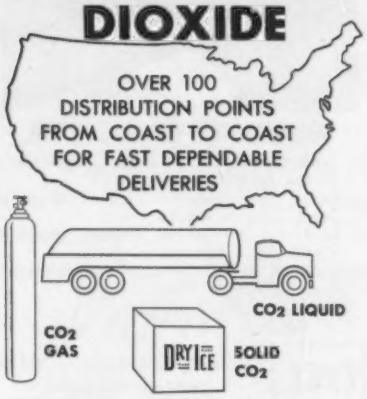

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Industry Notes

. . . *continued from page 77*

Production Techniques

Explosive forming, formerly directed toward high-strength metals, is being used for repetitive forming of common metals at Rocketdyne. Applications have included: ends of thrust chamber tubes of nickel and 20CB steel; stainless steel thrust chambers for a drone rocket engine; and 6061 aluminum pylons which attach Hound Dog to B-52's. Stiffeners for a large B-70 bulkhead were formed with a single female die. This saved about $500,000 in tooling costs.

Radar reflectivity range will be used in fabrication and flight testing of Redhead-Roadrunner target missile at Columbus Div., North American Aviation. Object: precise readings on missile surfaces which reflect radar signals; followed by attempts to reduce this area.

Electron beam welding of electrical connections for .030-inch-thick micro-assembly substrates is being developed for the Signal Corps at Hamilton Standard's Electronics Dept.

Coming Contracts

NASA will award a contract early in 1961 for developing an instrumented package to be soft-landed by Surveyor on the moon. Winner will be in line for NASA business totaling $50-million to $100-million. Hughes Aircraft, McDonnell Aircraft, North American Aviation, and Space Technology Labs are submitting competitive studies to NASA's Jet Propulsion Lab. This soft-landing package will follow Ranger hard-landing of Seismometer on moon in late 1962 or early 1963.

Four contract awards for preliminary work on NASA's Prospector (Saturn-boosted vehicle which will land a mobile laboratory on the moon) are expected this Spring. Development contracts are also expected shortly on Polar Orbiting Geophysical Observatories embodying "standardized" satellites. Prime contract on "POGO" is expected to run $50-million to $100-million over an eight year period.

Raytheon Streamlines Cable Assembly

Aluminum harness board, developed by Raytheon, is one answer to the scaling down of cable assembly costs.

Sheet aluminum is cut to size of harnesses. Wooden strapping is placed around the edges of the sheet stock. Next, a blueprint, which embodies complete harness details, is laid smoothly over the aluminum board and taped down.

A strong light source, placed behind the metal board, brings out the lines of the harness. Jig makers then simply place special steel pins (with metal collars on them) through the blueprint at close intervals, following the outlined configuration. When pins have been positioned, the laying-in of wire cables in the usual manner begins. Perforations in the aluminum board are staggered so that any combination of pins spaced to a tolerance of plus or minus ⅛ in. is accommodated.

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CABLE ASSEMBLY utilizes masking tape to hold down blueprint and legend details. Strapping has already been applied.

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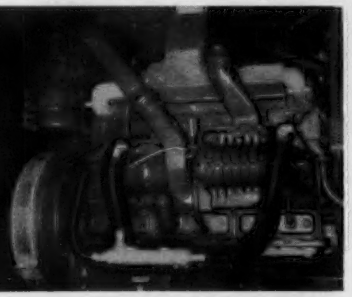

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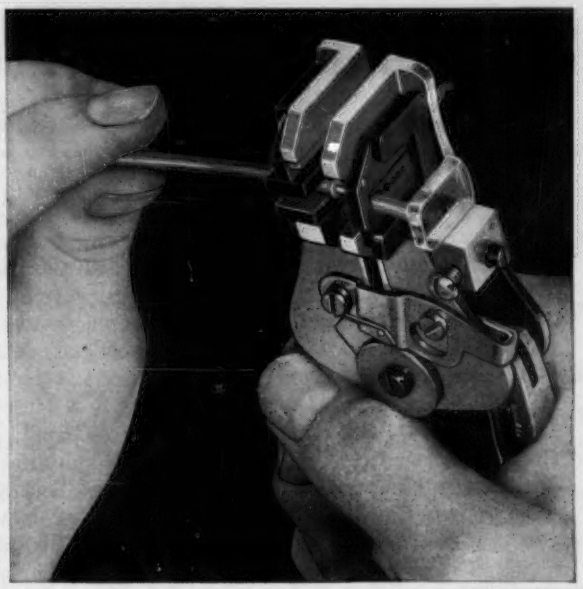

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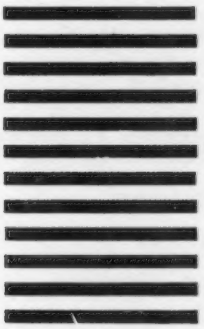

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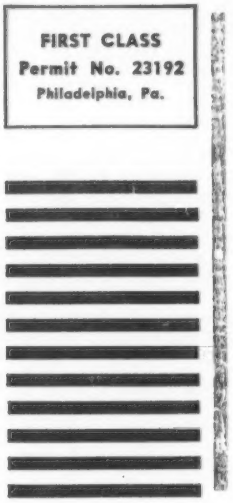

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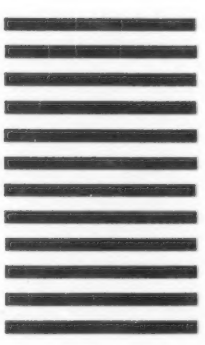

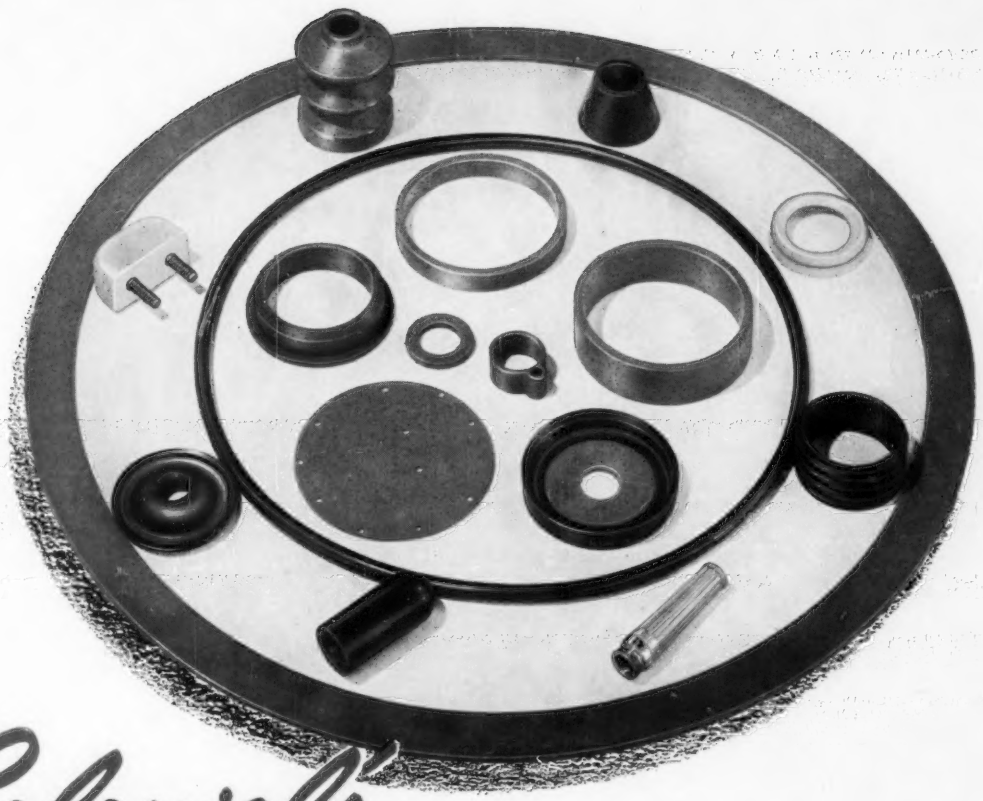

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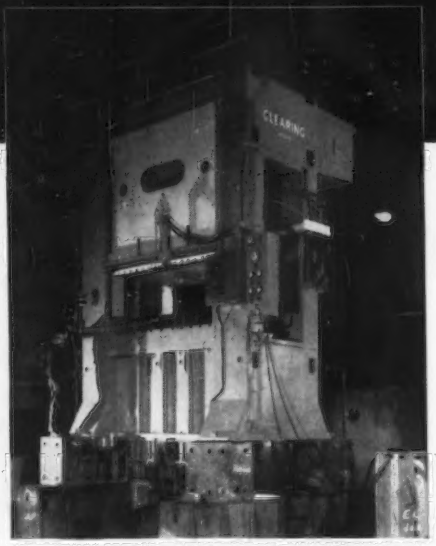
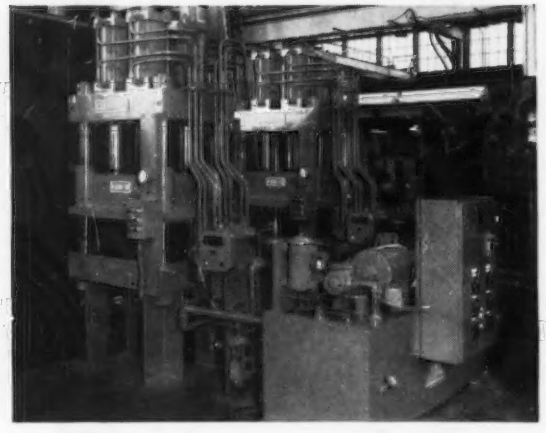


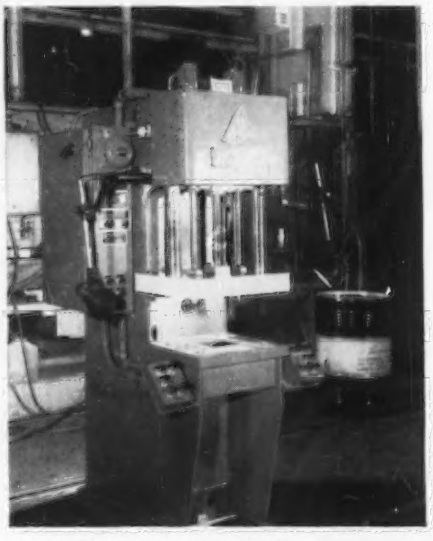
HEATING & AIR CONDITIONING PARTS—*FORMED*

Sheet metal parts are drawn on this 750 ton press designed to handle off-center loads with blank and draw dies using individually controlled cushions.



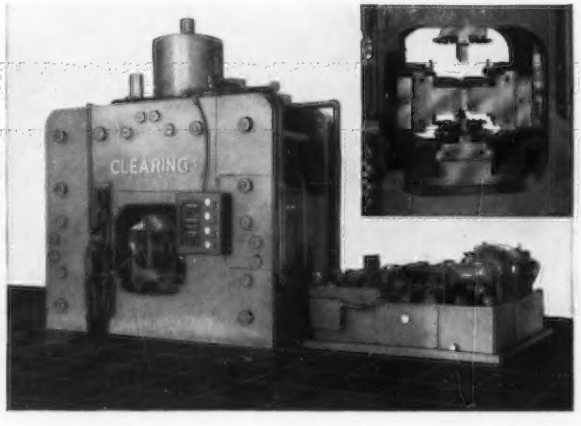
BOWLING BALLS—*MOLDING*

These two steam heated, 200 ton column-type hydraulic presses are designed for multiple cavity molding and operated from a single power source.



DIE CASTING—*TRIMMING*

High speed trimming is done on this 10 ton hydraulic gap press.



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